A Guide to the Drilling, Reaming, and Broaching a Bolt Action Receiver at Home

By Raymond Benwood

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Warning

At the time of the writing of this Book it was legal to make a firearm for personal use, provided the individual is not prohibited from doing so by Federal, State, or Local laws. Some States may have a prohibition on certain features or types of firearms a person may own.

It is up to the builder of any type of Personal Use Firearm to know and follow such law as may apply to them in the Jurisdiction in which they live. If in doubt, I encourage you to seek legal advice.

The Information presented here represents the knowledge and abilities of one man. Therefore, be advised that neither the author nor his family assumes any responsibility for the use or misuse of information contained in this book.

This book contains information that requires skills and knowledge of machine tools and their usage that would be of danger to an untrained or unskilled person. Therefore the information contained in this book is for information and education purposes only.

The author of this book is not a lawyer, therefore any references made by the author too any law does not represent legal advice.

For the sake of clearing up confusion on the home building of a Personal use Firearm, I have included a page from the web site of the BATFE along with their web address. As stated earlier at the time of the writing of this book building a Personal Use Firearm is legal. (Web page was saved early in 2006)

http://www.atf.treas.gov/firearms/faq/faq2.htm#a7

(A6) Does the GCA control the sale of firearms parts? [Back]
No, except that frames or receivers of firearms are "firearms" as defined in the law and subject to the same controls as complete firearms. Silencer parts are also firearms under the GCA, as well as under the National Firearms Act (NFA). Certain machinegun parts, such as conversion parts or kits, are also subject to the NFA.
The GCA generally prohibits the transfer and possession of large capacity ammunition feeding devices manufactured after September 13, 1994. "Large capacity ammunition feeding devices" are those that can accept more than 10 rounds of ammunition. [18 U. S. C. 921(a)(3), (24), and (31), 922(w), 27 CFR 178.11 and 178.40a]

(A7) Does the GCA prohibit anyone from making a handgun, shotgun or rifle? [Back]
With certain exceptions a firearm may be made by a nonlicensee provided it is not for sale and the maker is not prohibited from possessing firearms.
However, a person is prohibited from making a semiautomatic assault weapon or assembling a nonsporting semiautomatic rifle or nonsporting shotgun from imported parts. In addition, the making of an NFA firearm requires a tax payment and approval by ATF. An application to make a machinegun will not be approved unless documentation is submitted showing that the firearm is being made for a federal or state agency. [18 U. S. C. 922(o), (r), (v), and 923, 27 CFR 178.39, 178.40, 178.41 and 179.105]

(B5) Are there certain persons who cannot legally receive or possess firearms and/or ammunition? [Back]

Yes, a person who –

(1) Has been convicted in any court of, a crime punishable by imprisonment for a term exceeding 1 year;

(2) Is a fugitive from justice;

(3) Is an unlawful user of or addicted to any controlled substance;

(4) Has been adjudicated as a mental defective or has been committed to a mental institution;

(5) Is an alien illegally or unlawfully in the United states or an alien admitted to the United states under a nonimmigrant visa;

(6) Has been discharged from the Armed Forces under dishonorable conditions;

(7) Having been a citizen of the United states, has renounced his or her 8 citizenship;

(8) Is subject to a court order that restrains the person from harassing, stalking, or threatening an intimate partner or child of such intimate partner; or

(9) Has been convicted of a misdemeanor crime of domestic violence cannot lawfully receive, possess, ship, or transport a firearm. A person who is under indictment or information for a crime punishable by imprisonment for a term exceeding 1 year cannot lawfully receive a firearm. Such person may continue to lawfully possess firearms obtained prior to the indictment or information. [18 U. S. C. 922(g) and (n), 27 CFR 178.32(a) and (b)]

Introduction

This receiver was built with the tools and techniques discussed in this book

What started out as an unpleasant trip to the funeral home in the early 1990's has turned into an obsession.
It all started when family members began to reminisce about a family member that had worked as a cowboy in a western Rodeo show in the early 1900's.
Like many family members listening to the tales of long lost relatives, I tried to pay attention to every detail.

After I got home I had the opportunity to talk to my father about his grandfather and the gun work that he had done. Perhaps the most fascinating part of the conversation came when my father began to describe some of the gun work that had been done by his grandfather. Drilling gun barrels by hand with bits that were homemade, making gun parts that were first scribed onto a piece of steel, then cut out with a hacksaw and then shaped with a file.

Then the conversation exposed the revelation that has lead to this book and my interest in home gun building. My father began to describe some of the tools that he remembered his grandfather had made and used some 60 years before, single and multiple point cutters that were used to cut groves in guns. To this day I don't think my father realized what those tools really were, they were broaches. My father had described to me the broaching of a bolt action receiver and the making of a gun barrel by his grandfather without realizing it. It must be noted that my father was just a child at the time and did not understand what he was seeing.

Today we gun owners are lucky, we have modern firearms made from modern steels. Parts made by computer controlled machines, manufacturing large quantities of high quality interchangeable parts.

Lucky, well yes we have the benefit of modern steels and the quality of modern manufacturing, but my father, grandfather and great grandfather could buy guns through the mail, No background checks, No forms to fill out, nothing. To my way of thinking that is Freedom, something that we as a nation and people have lost.

In my opinion ever since the passage of the 1968 Gun Control Act, gun ownership in this country has come with permission slip. Homebuilding is not a way to bypass the law but does allow an individual some limited protection against future confiscation by building their own personal use firearm. Under the current law a person may build a firearm for personal use, but that firearm may NOT be sold nor can a firearm be built for another person other than the builder. The said firearm may be transferred upon the death of the builder, but again not sold. There maybe more to the current law, but that is my understanding.

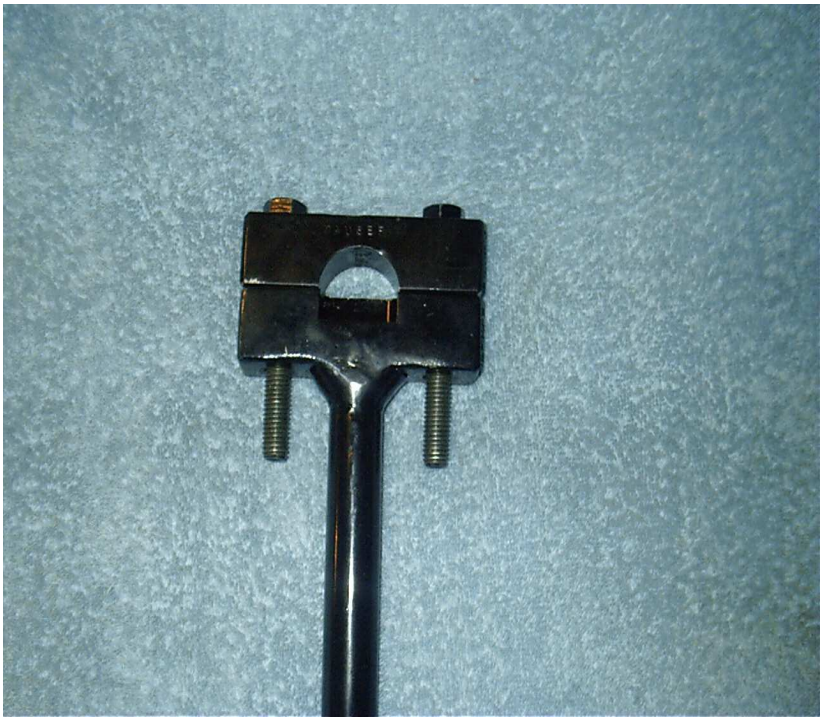
After September 11th, 2001 I began to hear about builder squads, groups of people that shared the cost of tooling and then built their own AR15's. The more that I looked into homebuilding; I discovered web sites and a whole industry supplying the home gunsmith and builder. I soon learned that many different types of firearms were being made; AR15's, 1911's, AK47's, single shots, and even 50 calibers.

Now if you are building a semi-auto rifle, pistol or a shot gun there are some rules that must be followed on the amount of imported parts that can be used. I won't cover that here because we are not building a semi-auto or shot gun, therefore the imported parts rule does not apply.

Now I am not a lawyer and I am not giving legal advice, but a rifle must have a barrel that is rifled and is at least 16 inches long. I suggest you never use a barrel less than 16.5 inches long. It's also my understanding that a rifle must be at least 26 inches in length overall. My suggestion is to make something close to a full size rifle or carbine and not try to test the law. I prefer carbines or what's called a scout rifle, they're around 38-40 inches in length.

Tools and Equipment

The biggest challenge to homebuilding firearms for the novice, is the investment



Above is a homemade action wrench used for Mauser and Springfield bolt action receivers. Such a wrench is necessary when replacing or installing a Barrel on a rifle. It's also the action wrench used for the bolt action that is discussed in this book.

in Machine Tooling and other equipment that is necessary to build firearms. Naturally if you wanted to build just one firearm, the cost would be prohibitive. However if you are wanting to build more than one firearm or are wanting to repair, maintain, or sporterize firearms the cost factor changes dramatically. Let's say you're a person that likes old guns and just wants to make general repairs or change barrels.

On some old bolt actions, this alone can justify the purchase of a lathe large enough to handle barrel work. What about repairing old or obsolete firearms, firearms old enough that parts are no longer available, this type of work can justify the purchase of a Milling Machine.

Many homebuilders make the holding fixtures, barrel vises, and action wrenches that they need to work on their firearms. They also porting gun barrels, rethreading, installing choke tubes, making firing pins the list goes on and on.

One of the main objectives of this book is to encourage and strengthen a second amendment culture in this country. I strongly encourage every reader to learn how to maintain and repair your firearms, to the very best of your abilities. I realize that the vast majority of people in this nation will never be capable of making their own personal use firearm, so it's up to those who can to keep homebuilding alive.

To determine what you need to buy first depends on what type of work you want to do. Barrel work will require a lathe that is large enough to handle both the length and diameter of the barrel. I know of many people that buy these little 7x10 or 7x12 lathes, but for legitimate barrel work there just too small. Another size of lathe that is often bought are these little 9x20 lathes made in China or Taiwan, again they are closer to the length that is needed but lack the slower speeds for threading, they also come with very small chucks. Now do not confuse these little imported lathes with lathes like the South Bend or other older USA made lathes. A 9x30 South Bend or Sheldon lathe has the slower speeds necessary for barrel work and have a reputation of quality built over decades. However for building the Mauser type receiver in this book, it will require a lathe that can handle at least an 8 inch 4 jaw independent chuck to accommodate the eccentric turning for the 3rd locking lug for the Mauser design.

There are many sizes and brands of lathes in the market place, 12x36, 13x40 and 16x40 will be some of the sizes that you will run across in selecting a lathe. I personally suggest you purchase a 13x40 lathe; this size is capable of handling a 10 inch, independent 4 jaw chuck. If you are a shopper of these wholesale and freight discount tool suppliers, it's possible to buy a 13x36 or 13x40 lathe for less than $3000.00. Now if $3000.00 scares you, you can buy a 12x36 lathe for $2000.00 that can still handle a minimum 8 inch, 4 jaw chuck. Now there is the possibility that someone makes a 10inch 4 jaw chucks for a 12 inch lathe it may cost extra, but it may save you $700-800 bucks, so shop around.

What about used lathes? Used lathes are just that, used. If you could find a good used USA made lathe that is not worn out and comes with good chucks and some tooling like cutters or a taper attachment for half the price of a new lathe then buy it.

Just remember one thing, it's called electric power. There are a lot of lathes out there that use 230 volt three phase power; this can be over come with the use of a converter.

If you buy a lathe, mill or any power equipment check the warranty before you make the purchase, some new tool warranties do not allow the use of a three phase converter.

There are new and used lathes out there that use 110-220 volt power, most homes have 220 volt single phase electric service. Now I know some are scratching their heads wondering what I'm talking about, most homes have 220 volt electric single phase service, but there are some older homes that still have the original 60 Amp 110 volt Rural Electric Service, if you live in an old home like that either buy only 110 volt equipment or upgrade your electrical service.

There is one curse to buying machine tools, that's keeping your better half from finding out about the cost of the little extra's like cutters and boring bars, if your single your ok, if not, don't worry you soon will be. (Just kidding) The bottom line is you will want some extra cutters and tooling so don't spend all of your money at one time.

The next big ticket item will be a milling machine. This is the one item where a Mini Mill or Mill/Drill is suitable. If you have the money buy a Knee Mill or larger Bridgeport style mill, but a $500.00 Mini Mill can do the job. If you do go with the Mini Mill, it is an absolute must that you buy one that uses R8 tooling.

The mill used for the receiver built in this book is a Mill/Drill. There are many Mill/Drills on the market, buy one that uses R8 tooling and has at least an 8x28 table. There are some Mill/Drills on the market that have direct powered heads, if you buy one of these mills buy the one that has a minimum of 1970 RPMs.

To build the receiver, we will use the Mill/Drill as a surface grinder to make the broaches needed to cut the raceways, so don't fudge on RPMs.

To grind the broaches we will need a 1 ¼ inch arbor with R8 shank. We will also need a white straight cup type grinding wheel

This is the R8 1 ¼ arbor and 5x 1 ½ x 1 ¼ white grinding wheel that will be needed to grind the broaches to size

You will need two 7/16 inch D style broaches, one 3/8 inch C style broach and one ¼ inch or 6mm C style broach. Broaches are expensive; I personally don't like imports, but if you need to save some money, then go ahead and buy the import broaches.

I have found the cheapest place to buy import brand broaches is from a machinery and supply company in Mentor Ohio.

You are going to need some specialty pillar files; these are long thin files with safe or non- cutting edges. Files are a funny thing I have bought El-cheapo files and high priced USA and Swiss made files and based on the application and use there is very little difference.

When I first started grinding broaches I ground a broach to cut the arc of the raceway, I soon found that I could get by with just a special cut file. The file that I use is a 12 inch long half round file that is ground down on both edges to the .4375 inch with of the raceway for a Mauser.

I used a 4 1/4 inch hand held grinder using regular grinding wheels, for metal. If you don't have a 4 ¼ inch grinder get one, El-cheapo works fine.

This is a picture of the files that I used to complete the receiver.

The bottom file is the 12 inch half round that I ground down to .4375 inches to fit the Mauser raceways. The next file above it is the long thin pillar file, with safe edges. It's needed for cleanup of the race ways. Hint: If you buy a good second cut file for the 12 inch half round file, the flat edge can do the work of the pillar file.

If you are buying drill bits for the first time, you can buy an assortment of drill bits and yes try to buy the best you can afford. To build your mauser receiver you will need a ½ inch 6 inch long bit to drill the pilot hole for the receiver, I then switched to an 11/16^{ths} bit at least 6in long to open up the hole.

I mentioned earlier to buy the best bits you can afford, you will need some 3mm and 7/32nd bits, don't go cheap, these are used to cut the holes for the receiver hold down screws, sear and bolt stop holes.

After I drill and bore for the barrel end I rotate the receiver stock and drill the opposite end, after drilling I ream the full length of the receiver with a 45/64 HSS reamer that is 9 inches long, straight spiral.

After reaming I hone with an 18mm flex type silicon carbide hone using transmission fluid as the cutting fluid.

I use both boring bars and a special ground 1 inch counter bore to bore the barrel end of the receiver and form the locking lug area in the receiver. I also use a 13/16 and 1 ¼ counter bore, I use the 13/16th counter bore to bore the bolt shroud relief area, the 1 ¼ counter bore is to form the rear hold down bolt tang.

Counter bores are end cutting only, and are slightly oversize. I ground the sides of a 1 inch counter bore slightly so it would cut a little less than one inch. I use this counter bore to cut the barrel opening and form the locking lug area at the same time. However if your lathe has a sloppy tail stock or your set up is not ridged, I suggest you use a cobalt or carbide tipped boring bar or you will have an oval shaped hole.

The miscellaneous tools will be a 4x6 power metal saw to cut the receiver stock or hack saw with a blade for metal, layout dye, scribe, punches, and ¼ x28 inch taps.

You're going to need end mills ½ and 3/8 inch, carbide or cobalt is a must. Standard end mills could be HSS, but I am finding that carbide or cobalt work best. Standard length 3/8 and ½ inch can do most of the milling.

To cut the magazine feed rails I use a 3/16 inch cobalt end mill with 3/8th shaft. To cut the cartridge feed ramp you must have a long 7/16th end mill.

Contours are cut with 3/8 and ½ inch ball end mill's don't skimp here and buy El-cheapo's.

Chapter Two

The Strength is in the Steel

I hope your still excited about homebuilding your own personal use firearm.

This chapter will be very short and simple, if your going to build a firearm you must absolutely use the right steel for the application. There are many designs out there, some good, some bad, and some down right horrible, but every receiver must be made with steel capable of handling the pressure for the cartridge it was designed for or you will have a disaster.

I use one design in my home built bolt action firearms, Mauser, why Mauser? it's a design that is time tested for over a century. The large ring Mauser may be the safest design ever built for a bolt action rifle and it's not because of the 3rd locking lug.

The original Mausers were built at a time when many firearms still used black powder as the cartridge propellant. To make new advances in firearm and cartridge designs, new developments in heat treating and steel production had to be made first.

There is a lot a debate on the type of steel used to make the Mauser receiver, the best guess is a medium carbon steel similar to 1030 with a little extra magnesium thrown in to ease machining. The Mausers were then machined from a forging and case hardened. By modern standards a simple case hardening for a bolt action receiver firing a cartridge that develops a chamber pressure of 49,000 cup would never get past the corporate lawyers.

For my home built Mauser I used 4140 pre-hardened steel. 4140 is readily available everywhere in the country, now that doesn't mean every supplier has it setting on the shelf, but 4140 can be purchased from suppliers though the mail, over the internet, and at local machine shops.

If your going to buy it from a local machine shop make certain its 4140 Pre-hard and not annealed or something else like 1018 cold rolled steel. I say this because I went to a local supplier a big machine shop that claimed to have 4140 pre-hard in stock. The guy went over to a big rack picked up a piece and said here you go, I asked do you have any Stress Proof, he went to the same spot on the rack picked up a piece of steel and said, here you go.

There is no way in hell I would use that steel to make a receiver, you must absolutely know the type of steel you are using when making gun parts. That's why big suppliers that sell over the internet or out of catalogs may be the safest place to buy steel in small quantities.

Now I know there are other types of steel that could be used to make a receiver, fatigue proof and flextor. In a survivalist situation, Stress Proof could be used provided you build your receiver for a lower pressure cartridge, like 7mm Mauser or 7.62x39. Car, truck, or tractor axles could also be used, but I would only consider this in a desperate survivalist situation.

Any steel that you use you want to be certain about its hardness. The best way to determine the hardness of steel is by using Hardness testing equipment. If you had heat treating equipment and the know how to use it, 1040, 4130, 4340 and 4350 could all be used.

I have read on the internet where some homebuilders send their receivers out to be heat treated. Let me give you a word of warning, not everyone knows the law on home building firearms, not even the police.

When you complete a firearm even before its heat treated, by law it is a firearm. Unless you are an FFL dealer, sending a firearm through the mail is a felony, plus some states have laws about firearms needing serial numbers or identification marks. Under current federal law a homebuilt firearm does not require a serial number, but it is suggested that they are marked with the makers name and town.

This is why I make my home built receivers out of 4140 pre-hard steel. In my opinion it's strong enough to handle any standard cartridge in the .473 head size. This is the case head size of the 30-06, 308, 243, 22-250, 7 and 8mm Mauser.

Every one has their own ideas about how strong a receiver should be they go on to the internet and read about some bench rest rifle with a receiver hardness of 35-45 on the Rockwell C scale and think their rifle should be just as hard. Those types of rifles are designed to be ridged for long shots, using very high pressure rounds, up to 65,000cup.

When Uncle Sam was upgrading from the Krag to the Springfield, those rifles were proofed at 70,000 cup and from what I have read; Paul Mauser proofed his receivers at 66,000 cup.

Different manufactures have slightly different ratings for their steel, 4140 pre-hard on average has a tensile strength of 150,000 psi and yield strength of 128,000 psi.

Some manufacturers list their steel by a hardness scale from 28-34 RC. This means the steel is suitable for most applications that require hardness in that given range.

There are actually formulas to determine what strength of steel should be used for a given design, but since I am using a proven design instead of making my own, I look at the steels yield strength only.

Now I must admit looking at the yield strength of a steel is an over simplification for determining the type of steel used in a firearm, but 4140 has a long history of use in firearm manufacturing.

Chapter Three

Receiver Design

I started my quest on homebuilding in 1998, having waited almost eight years before I even acted on the knowledge of broaching a receiver. I was certain that I could broach the raceways of a bolt action receiver, but the question was what design to copy.

Being an admirer of the bolt action Mauser the decision was easy. In my opinion Paul Mauser was a genius; his bolt action design has lasted for over a century and is still being manufactured to this day.

When I started to duplicate the Mauser I realized there was one Mauser feature that I could not duplicate, the inner locking ring. I think Paul Mauser added the ring to his design just to aggravate other designers and to confound state run arsenals that might try to copy his design without a licensing agreement.

My version of the Mauser also has a slightly different variation on the extraction cam area of the receiver, but other than that it's very similar. I do take a little liberty with the Mauser design, I use a round piece of 4140 pre-hard steel 1 ¾ inches in diameter 8 ¾ inches long, because of this the recoil lug is round bottomed instead of flat. I believe the round bottom still provides sufficient area to act as a recoil lug. If you want your version to have a flat recoil lug, then use a larger piece of steel.

Some homebuilders want to build from scratch, I say go for it, but for me, I prefer the mauser design, because of the availability of parts and over the counter accessories The fact that I can buy stocks, bolts, triggers and sears is enough for me to stay with the mauser, I like it easy.

Now you don't have to use strictly a Mauser bolt with this design. For now I'm using a Mauser bolt, but if the price of Mauser bolts keep rising, I'm going to switch to a 1903 Springfield bolt. One plus of the Springfield bolt is that you don't have to mill the third locking lug slot.

Now I do not consider an internal eccentric cut to be a problem, but the Springfield bolt may be an option to those looking for an alternative to the eccentric cut. There is one draw back to the Springfield bolt, the bridge end must be tall enough to accommodate the safety lug grove, but that's not a problem either.

If you are looking for a Mauser alternative with out the third locking lug, try a bolt from a small ring Mauser. I would for safety reasons add the safety notch in the receiver similar to the 95 Chilean. Another option could be a bolt from a 700 Remington. So don't think you're married to a Large Ring Mauser bolt.

If you are going to build a bolt action receiver using a bolt other than a large ring Mauser, first measure the width of the bolts locking lugs, before you buy any broaches. One reason I like the Mauser is that the standard 7/16 inch D style broaches can be used to cut the raceways.

Now don't get upset if you want to use a Springfield bolt and find out that the locking lugs measure .400 inches wide. A 10mm D style broach measures .394-.395 inches and can replace the 7/16 inch D style used for the Mauser, a little tight, but this allows for some final fit and a little polishing.

Now if you need a broach for a raceway that a corresponding standard or metric broach size is not available, find someone with a surface grinder and have a ½ inch D style broach ground down to the size you need.

I like a lot of people would prefer to buy made in the USA, but unfortunately that may not always be an option. Broaches can be bought any where, the USA made broaches may be the best ever made, but they are expensive, if cash is short don't be afraid of the imports.

There are many wholesale and industrial supply businesses on the internet, so do a web search and see what you can find. The cheapest place I have found for new import broaches is from an industrial supplier in Mentor Ohio.

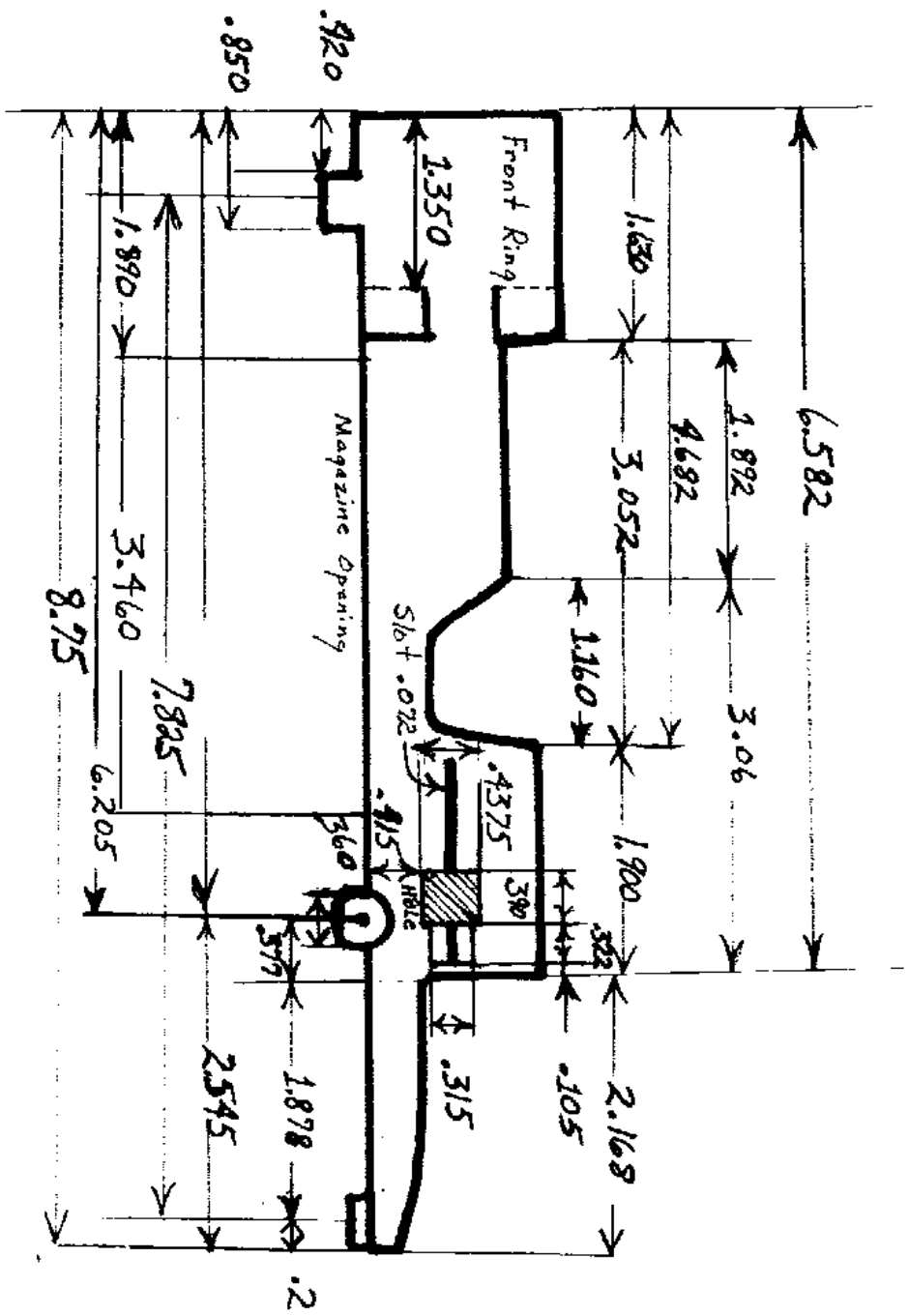
Some of these internet wholesale and industrial suppliers only offer the more common sizes of import broaches, but I promise you there is a 7/16 inch import broach available, because I own one.

I am including hand drawings of the Mauser receiver that I built. I believe all of the dimensions are accurate, but check your measurements before you start.

I like to make my receivers just a little oversize for final finishing. I also cut my barrel and receiver threads using a 1 1/8th, 12 thread/inch USA made tap and die.

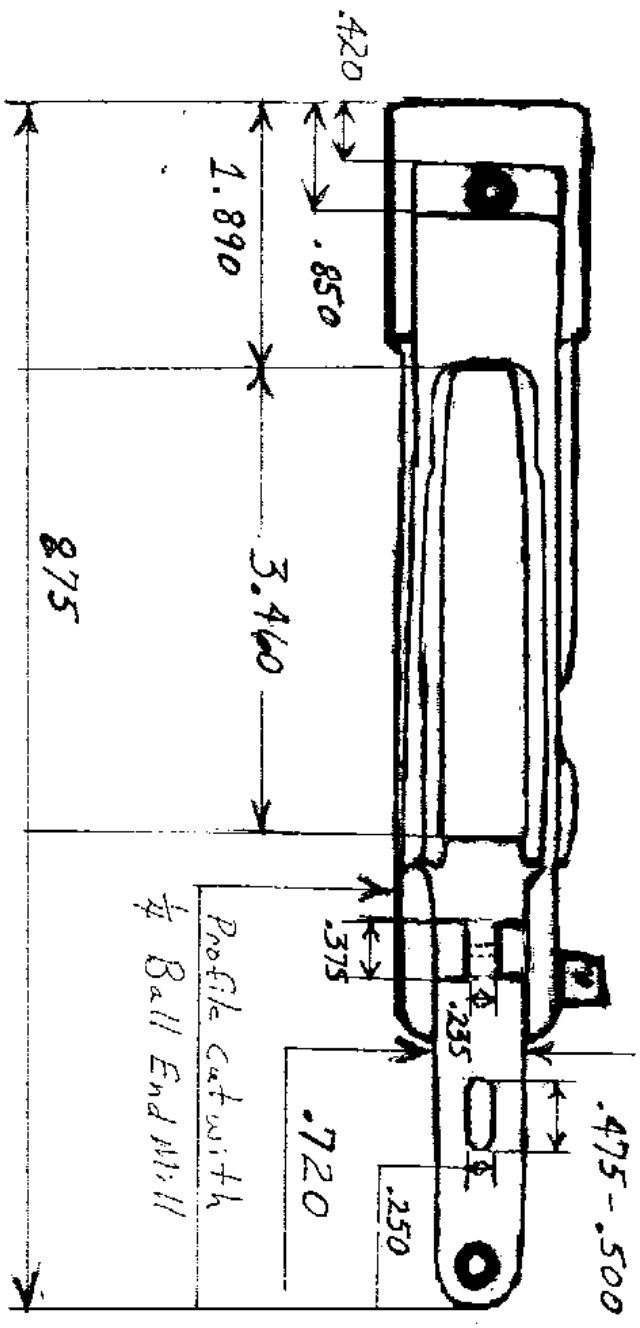
The real Mauser uses 12 threads/inch, but with a barrel shank diameter of 1.100 inches.

This means a standard Mauser barrel will not work in my home built receivers, but you can build your receiver to accommodate a standard Mauser barrel or any size you want. So keep this in mind before you commit to a barrel.



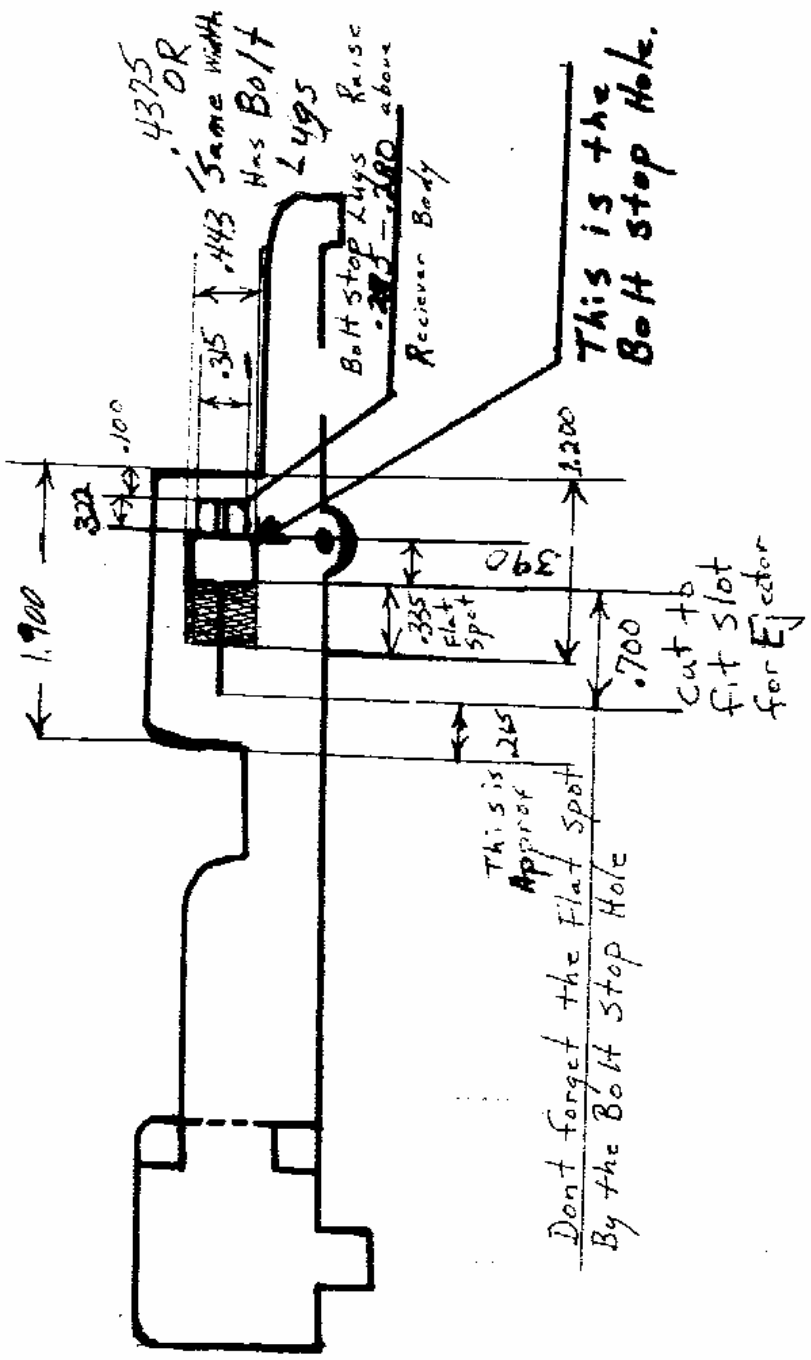
Full size Mauser Receiver (Large Ring)

Drawing #1



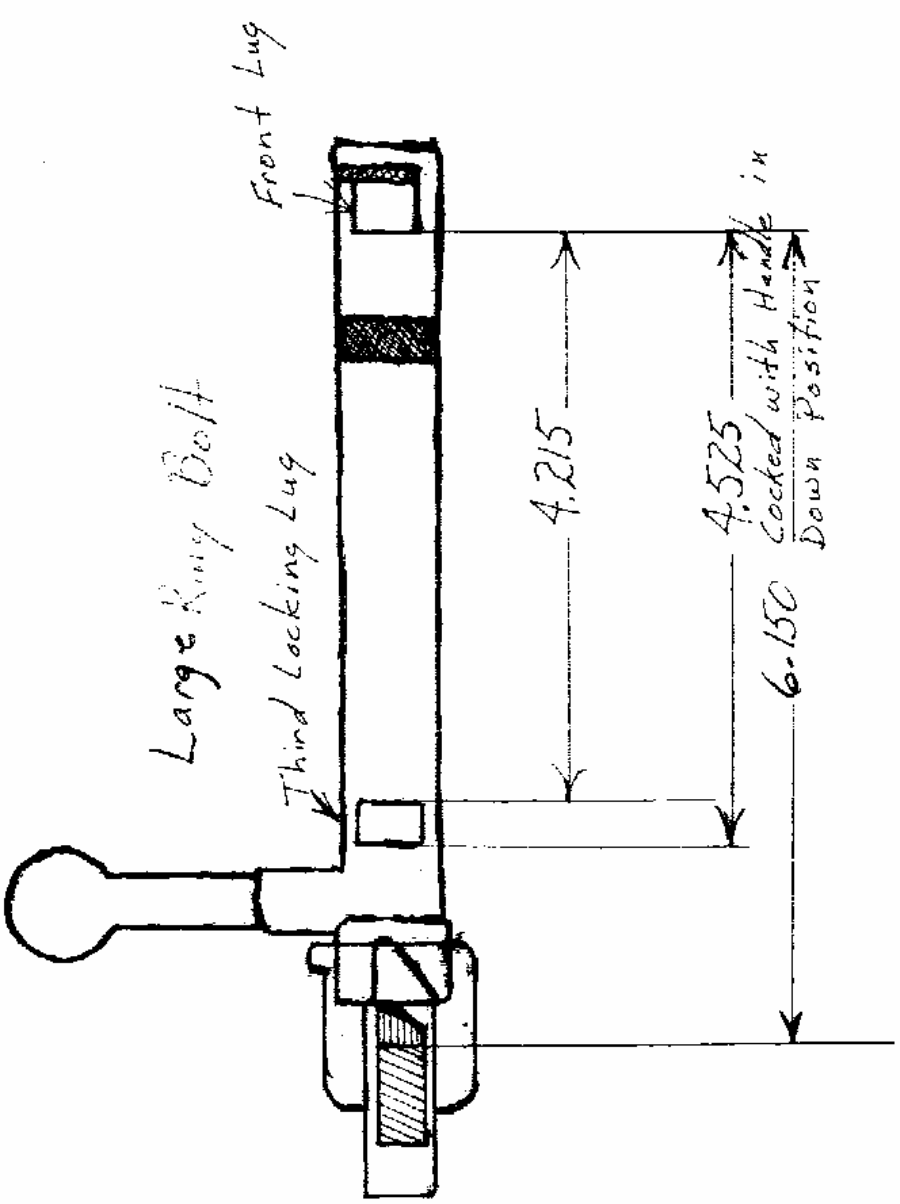
Mauser Magazine Feed Lip View. Notice the shape of the magazine opening and how they are shaped. These were made using the templates on page 17

Drawing #2



Mauser Bolt Stop Hole

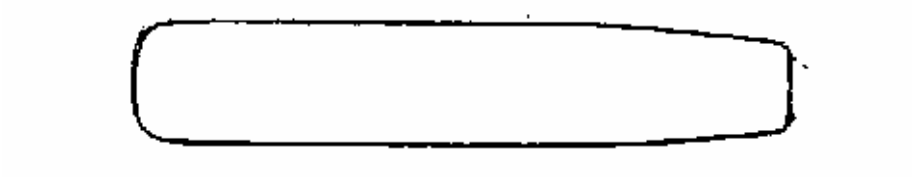
Drawing #3



Full size Mauser bolt showing the distance between the front locking lug contact area and the third safety lug. Also note the distance from the locking lug to the cocking piece, measurement taken when the bolt is in a cocked position with the bolt handle down as if it were in a firing position, this measurement is needed for proper sear placement.

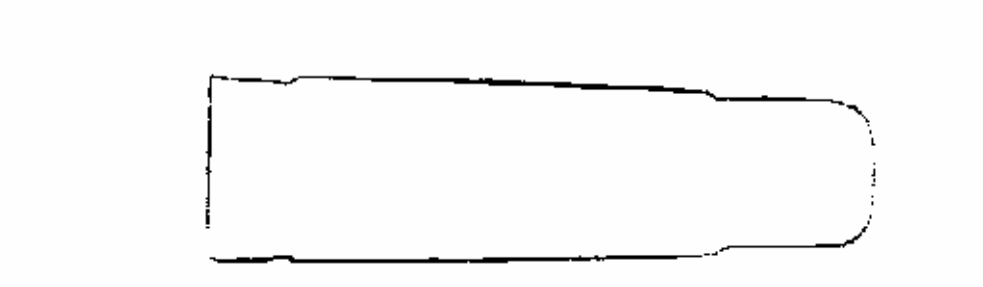
Hint: safety lug does not contact receiver

Drawing #4



This is the inside magazine template #1

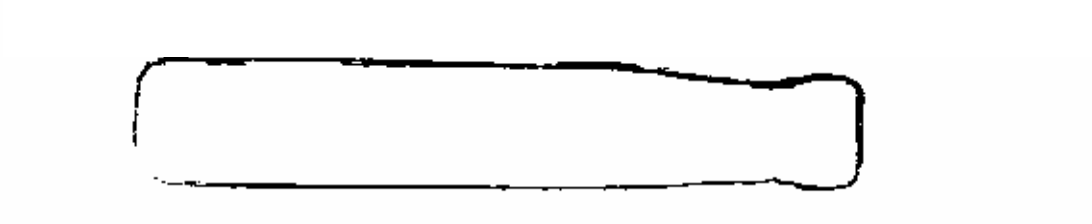
This is the first template I use. I lay it centered on the flat side of the receiver, starting where the magazine and cartridge feed ramp meet and then scribe around it. Remember the inside edge of the trigger guard/magazine sets flush with the End of the cartridge feed ramp. This profile was taken from an actual receiver.



This is the outside magazine profile template #2

This is the second template I use. I lay it centered over the scribed lines of template #1. I then scribe around it. This allows me too cut the magazine opening profile, plus creates the magazine feed lips profile. I have tried to get templates #1and #2 to be the actual size of the templates that I used for the milling of the magazine feed lips. You should check them for size against an actual Receiver before proceeding to cut your magazine opening.

Hint: Print out and paste to a thin piece of metal, then cut on the line to size



This is the magazine inside magazine feed lip contour gauge that I use to check the profile of the feed lips. Notice the slight half hour glass shape near the barrel end of the gauge, without this hour glass shape the cartridge will not feed properly.

Hint: There must not be any sharp edges to snag the cartridge, if the cartridge will not pass through the hour glass shape, try polishing before you begin to enlarge the opening

Chapter Four

Grinding the Broaches

The broach on the left is a full size 7/16 inch D style broach shown for reference purposes only.
The broach in the middle is a 7/16 inch D style broach ground down to complete final sizing for the receiver raceways.
The broach on the right is a 7/16 inch Broach that has been ground down and is the second broach used in the step broaching technique used to create the receiver made in this book

Some people may be wondering why we are grinding down standard keyway broaches and not buying broaches already made for cutting raceways for a bolt action receiver, the reason is simple, cost.

Broaches used by commercial firearm manufacturers used to broach bolt action receivers also require a very large hydraulic broaching machine rated at several tons and I might add weighs several tons. Such equipment is beyond the reach of the homebuilder, even finding a place to put such a machine would overwhelm most home shops.

To broach my Mauser receiver I used one 3/8ths C type push broach, two 7/16ths D style push broaches and either one ¼ inch or 6mm C style push type broach for the bolt guide slot. I personally used the ¼ inch broach it works just fine, although I do have a 6mm broach on hand.

We will also need to make a round bushing .700 inches in diameter, 8 inches long, with a 3/8ths slot milled full length to accommodate the 3/8ths and ¼ inch C style broaches. The sleeve once milled will be very thin at the bottom, about .120 inches in thickness.

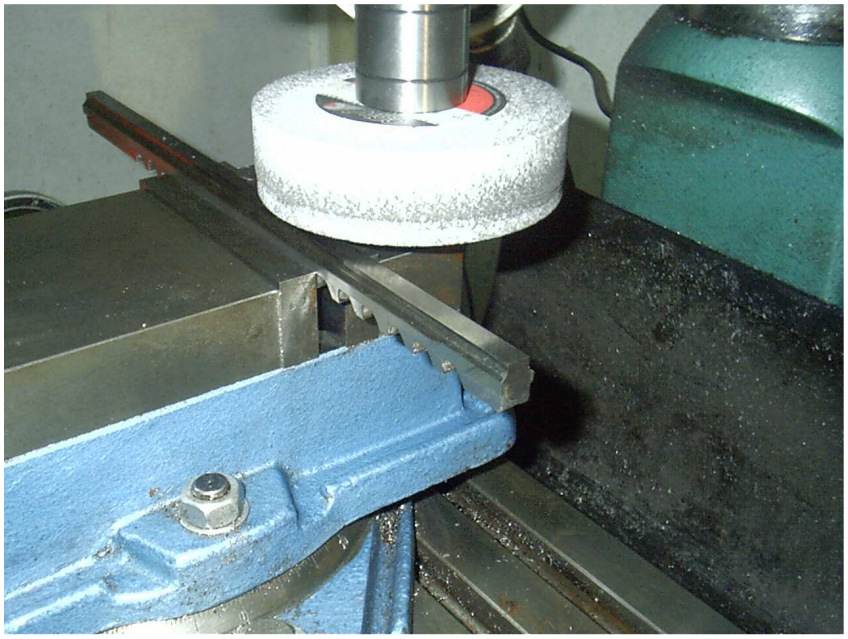
The bottom of this slot will be flat leaving the corners at the bottom only about .060ths of an inch thick. I used a piece of ¾ inch drill rod to make my sleeve, I suggest you either use drill rod, stress proof or 4140 pre-hard to make your sleeve, there is a lot of stress on this thin little sleeve and it's got to be strong.

I had used my sleeve several times, before I took the first picture, so it's a little beat up, but I expect to finish several more receivers before I make another. If you screw up don't worry, just make another. A piece of ¾ inch drill rod is not that expensive.

Every broach used will have to be ground down or altered in some way. I thought about having my broaches ground by someone with a surface grinder, but I was unsure about the final dimensions, plus I didn't want to have to answer the stupid questions from the guys at the machine shop, so I came up with a way to grind the broaches on a Mill/Drill or its equivalent. I suggest that if you own or have access to a surface grinder, that you grind your broaches with it. It will be faster and you will have a greater chance of success.

I feel the need to pause and make a comment. Not everyone you deal with will know or understand the laws about homebuilding. I encourage you to use common sense. What is legal today may be illegal tomorrow, therefore I suggest that you DO NOT advertise your homebuilding hobby, unless you really know to whom you are talking and dealing with, don't become jail bait.

To grind my broaches, I used a 1 ¼ inch arbor with an R8 shank. To the arbor I attached a 5”x1 ½”x1 ¼” straight cup type grinding wheel, white in color, fine grit. I mounted the arbor, with wheel onto the mill/drill.



On the milling table I mounted a 5 inch milling quality smooth jawed vise. I then placed one of the 7/16 inch “D” style broaches in the vise; with the cutting side down, making certain that the ridge next to the teeth touches the top of the vise jaws. You can protect the teeth if you wish with duct tape or thin strips of copper.

The height of a new 7/16 inch “D” style broach measures .850inches in the front and .910inches at the back. I took the measurements at the very ends. The cutting area is 7/16 inches wide and the width of the back or base is 9/16 inches. Both the USA and import “D” style broaches that I own have these same measurements.

I hold the broach in a vise so that I can set the back of the broach level. The difference in the height of a broach is made when the teeth are ground and not by grinding the back. If you set a broach cutting teeth down flat on a milling or grinding table and then ground the back of the broach level, you would end up with a broach that would not cut.

Both of the 7/16 inch broaches must have a total of .140 of an inch removed from the back. When you are finished grinding the back, the broaches will measure .710 inches on the front and .770 inches on the back. When I began grinding I made very shallow passes, no more than .002 per pass.

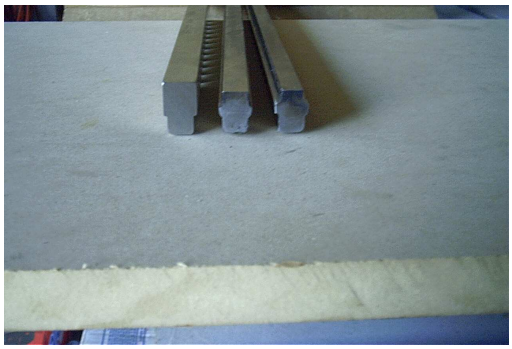
Now I know the broach is not supported on the ends. I quickly learned that I could make two or three passes and stop, let the broach cool naturally and not have a problem with warping.

Originally I tried holding the broach on the ends and using wet paper towels and heat control paste and found that I could still warp the broach. I know this is unorthodox, letting it hang out there, but it works, you just have to go slow.

I found that I could make between two and four passes, go piddle around for 5 minutes come back and repeat the process and be fine. If you want to grind your own set of broaches using this method, be prepared to spend a whole weekend.

After I ground the height of the broach, I then lowered the cup grinding wheel to grind the sides. A new 7/16ths "D" style broach has an overall width of 9/16ths of an inch. The back of one of the 7/16ths broaches is ground to an overall width of 3/8ths of an inch and the other is ground to an overall width of 7/16ths of an inch.

On the broach that will become .375 inches after grinding, I ground .0940 thousands of an inch off each side, the other broach I ground .0640 thousands of an inch off each side.



The picture on the right shows the comparison between the broaches. When I originally ground the broaches, for added strength, I left about .050ths of an inch of the original 9/16 inch width protrude from the broaches, below the area I had ground. Later, I found that the broach which cuts 3/8^{ths} of an inch wide at the back can not have these protrusions; it must instead be ground to an overall width of 7/16^{ths} of an inch.

I found that these protrusions kept the broach from making the maximum depth of cut that I needed to complete the raceway.

The 3/8 inch "C" type broach needs to have .015th removed from its back to allow it to set in the sleeve and pass through the hole of the receiver. I did this on a 4x36 belt sander fitted with a blue silicon carbide belt, an aluminum oxide or red belt would not cut the tool steel of the broach.

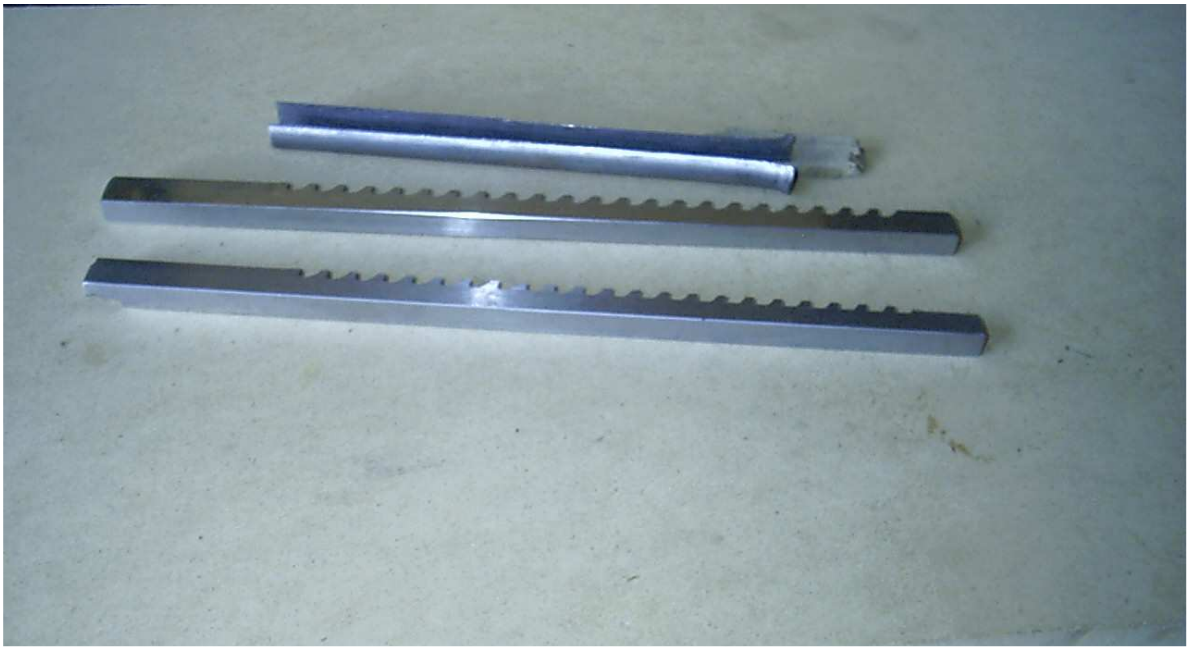
Both the 3/8 inch and ¼ inch "C" type broaches will need the square edge part of the nose, slightly rounded to traverse the round hole of the receiver. I rounded the edges of both broaches with a 4 ½ inch hand held grinder, after placing them in a vise.

When I originally started grinding broaches I ground a broach that allowed me to cut the arc of the diameter of the bolt lugs. I soon realized that this was a waste of money, because I still had to fit the bolt to the raceways using a special ground file.

The file that I used was a 12 inch long half round file that I ground down freehand with my hand grinder. I would occasionally stop check my progress with a straight edge, correct any high spots and then continue.

I cut from both sides on the file until I had a file 7/16th of an inch wide and 12inches long. Surprisingly this went very well; the file I used was a high quality USA made file and it never lost its hardness.

I only stopped a couple of times to let it cool. For some reason the grinding wheels I used didn't make the thing hot. I'm now considering using the hand grinder to rough out my next broach.



This is a picture of both the 3/8 inch and ¼ inch broaches, the long thin sleeve is the sleeve I made from drill rod for the “C” type broaches to cut the bolt guide slot (1/4 inch broach) and start the raceways.

Starting the Receiver

I start the receiver by cutting a piece of 4140 pre-hard 1 ¾ inches in diameter and slightly over 8 ¾ inches long. I center the blank stock in a 4 jaw independent chuck in the lathe for boring. I begin by drilling a pilot hole in the center of the blank stock. I then drill a ½ inch hole at least 4 ½ inches long, using cutting oil. One thing that I need to mention is that 4140 pre-hard is very hard steel, I use HSS USA made drill bits. If you crowd the drill bit while you are drilling you can easily break or dull the bit. You must use steady pressure and plenty of cutting oil. If you linger as you feed the bit you can actually work harden the already hardened 4140, if that happens you may be done with that piece of metal unless you use a carbide bit or carbide tipped boring bar.

After I drill the ½ inch hole, I switch to an 11/16 inch drill bit and repeat drilling the same 4 ½ inch hole. I then face off the receiver, so that I have a clean and trued edge. This is why I make the blank stock slightly longer than 8 ¾ inches long, before mounting in the chuck, just don't shorten the receiver blank to less than 8 ¾ inches long.

The next step is boring for the barrel shank. I use a special ground 1"inch counter bore to form both the barrel shank and form the square face that will be the receivers locking lugs. I suggest that you use carbide tipped boring bar to do this operation. The easy way to set the carbide tipped boring bar is to use the trued face of the receiver blank as a gauge. I bore this hole 1.350 inches deep. I use a dial gauge set on the lathes tailstock. You can also use a dial gauge set on the lathe bed.

This picture shows not only the front locking lugs, but the broached raceways. Notice how the locking lug is really just a shoulder in the barrel end of the receiver blank. It's absolutely necessary to get the front locking lug square to the barrel opening.

The depth of the bore must be 1.350 inches long for a Mauser. The diameter of the bore will depend on the diameter of the barrel shank. If you want to use a standard Mauser barrel do not exceed 1inch for the barrel bore.

You should now have an 11/16 inch hole half way through the receiver blank, with a .980-1.00 inch diameter hole, 1.350 inches long in what will now be the barrel end of the receiver blank.

Next I loosen the chuck slightly and remove the receiver blank from the chuck. I then turn the receiver blank 180 degrees and then reinsert the blank into the lathe chuck. I then center the receiver blank in the chuck and drill a pilot hole. I then take my ½ inch, 6 inch long drill bit and drill a hole the remaining distance through the receiver stock using plenty of cutting oil. Next I enlarge the hole with my 11/16 inch, 6 inch long drill bit.

Now I change to a 13/16 inch counter bore or drill bit. Using a dial gauge mounted on the tail stock, I then bore a hole 2.375 inches deep into the bridge end of the receiver blank. This cut forms the arc needed to accommodate the raised area on the rear of a Mauser bolt and clearance for the bolt shroud.

Now don't forget this step, it can be done later but will have to be done with a boring bar. The 2.375 inch distance is for the full length large ring Mauser. If you are using a bolt other than a Mauser or are building a receiver for an intermediate Mauser bolt, you must change this cut accordingly.

Leaving the receiver blank in the chuck I now install a 45/64th reamer in the tailstock chuck and ream the receiver blank to accommodate the bolt diameter. Make sure you use plenty of oil here and don't let the metal chips bind the reamer. I ream from the bridge end intentionally, most tail stocks have a small amount of wear causing a slight taper at the start of the hole. Since Mauser receivers have this slight taper, we recreate it using this method.

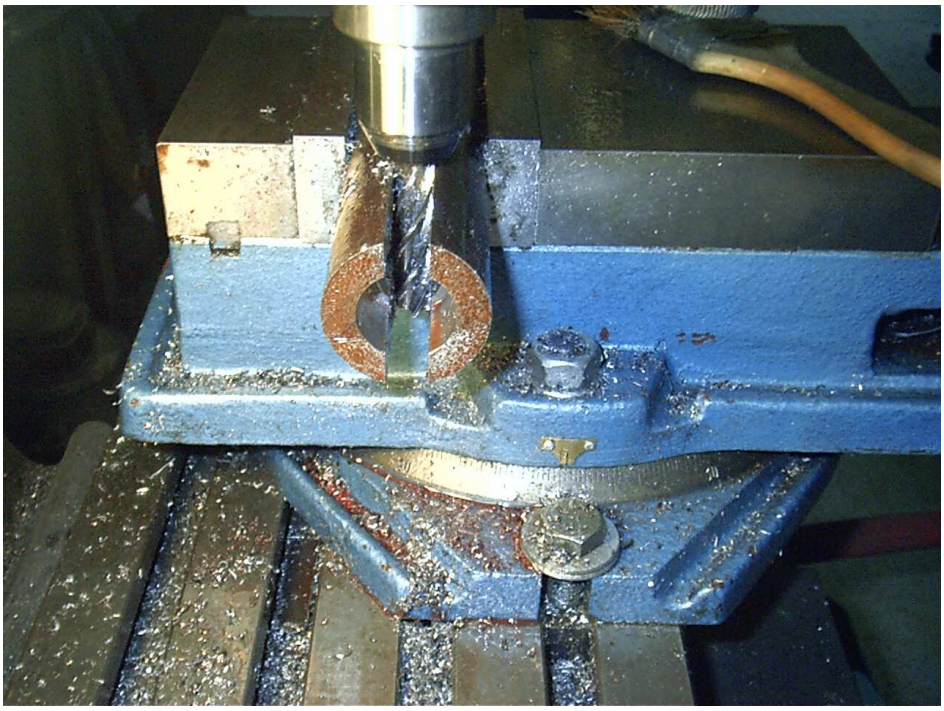
I now hone the newly reamed hole using an 18mm fine grit silicon carbide flex hone. Use plenty of honing oil (transmission fluid) and do not over hone you are looking for a maximum diameter of no more than .705 inches. I have seen Mauser bolt bores as large as .707 inches but don't go that far we want a tighter bore for accuracy.

This is the 45/64th HSS reamer I use for reaming the receiver blank to accommodate the bolt.

The counter bore in the picture is a 1 inch counter bore that I ground down slightly undersize (.980) to bore the breech end of the receiver and form the square shoulder that becomes the receiver locking lugs.

The lower tool is a center finder that I use in the last step of finishing the receiver blank to find top dead center.

The counter bore is an interchangeable pilot style.



This is the secret to broaching a receiver in the home shop. The gullets of a standard broach will not handle the amount of material needed to cut the raceways of a receiver, but by changing the distance the broach must travel, the impossible, becomes possible.

I start by mounting a 5 inch milling quality vise on the table of the milling machine making certain the vise jaws are parallel to the cutter. I then place the receiver blank in the vise and secure.

Next I find absolute top dead center using a center finder. I then begin milling a slot 2.100 inches long, using a long 7/16th of an inch wide center cutting end mill.

This is the first step in forming the tang end of the receiver; I will mill the tang to its proper length of 2.168 inches in a later step. This new flat area will also be used as an indexing area for future layout, so make sure you are milling at top dead center of the receiver blank.

Hint you may want to start using a shorter 7/16 inch carbide end mill to start the slot milling. After you complete the top of the slot you can then switch to the longer end mill.

Do not try to cut the slot in one pass, unless you have the equipment to do so.

If you are going to use a bolt other than a large ring Mauser, you must change the length of the slot to accommodate the bolt.

If you want to duplicate a 700 Remington bolt action receiver, I suggest you eliminate the slotting of the receiver all together.

The Remington receiver has a taper at the bridge end of the receiver that gives it, its unique profile.

I suggest that you bore the bolt sleeve end of the receiver with a 1 inch counter bore to the proper depth to accommodate the width of the bolts shroud. This should give you plenty of room for the broach to cut the raceways.

The only thing that will change is the height of the sleeve, it will set lower in the receiver. After broaching you can mill the Remington tang to profile.

Chapter Six

Broaching the Receiver

I expect this chapter to be read more than any chapter in my book. I have been a visitor to many gun smithing and gun building web sites since 1998.

When the discussion was about building a bolt action receiver and the difficulty involved, the problem was always the raceways. It's my sincere hope that this chapter answers a lot questions for many people in the homebuilding community.

Let's get started!

You will need a 20 ton shop press and an old 3 jaw lathe chuck. The shop press needs to be a good one, the cheap Chinese presses may work, but only if they are ridged. The old 3 jaw lathe chuck must have center hole large enough to allow the receiver blank to set flat on the press plates.

You will also need those two 7/16ths broaches and the 3/8ths broach that we ground down in the previous chapter, along with that thin sleeve. I also cut 4 shims .020 of an inch thick. I cut mine from a piece of 29gauge sheet metal.

Set the chuck in the press and insert the receiver blank barrel end first into the chuck with the slot opening facing toward the operator.

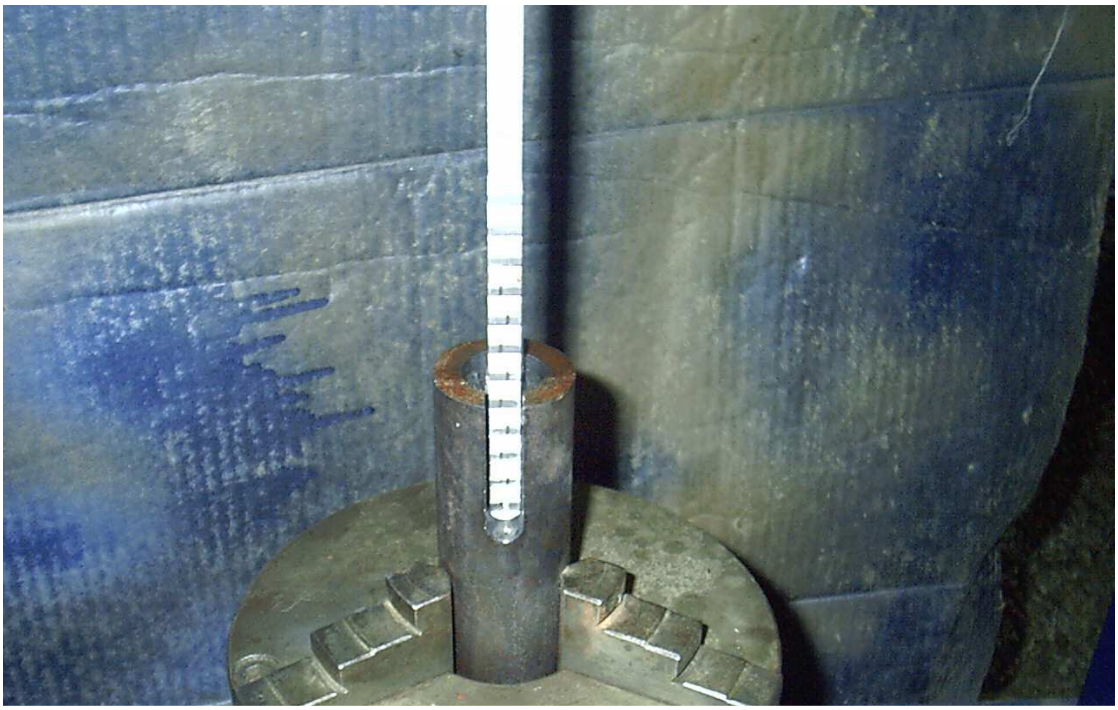
Now we are going to do something unconventional. We are pushing a square broach down a round hole. In this case the round hole is .705-.707 inches in diameter. What we want to do is remove a small amount of metal to help the nose of the broach travel down the receiver blank.

To do this I insert the 3/8 inch broach onto the hole of the receiver blank WITHOUT the sleeve, aligning it with the slot.

Yes you read correctly. Now make certain that the broach is aligned with the slot as seen in the next picture. Now press the broach down and through the receiver blank.

What you have done is cut two small grooves down the full length of the receiver blank. The broach should have pressed fairly easy down the hole, if it binds or stick's go back to the grinding the broach chapter and follow the instructions for removing approximately .015th of an inch off of the back of the broach.

If the broach was burred polish it on the 4x36 belt sander with the silicon carbide belt.



Now reinsert the broach 180 degrees in the receiver blank, align the broach as before and press it down through the receiver blank. The broach should practically fall through the hole leaving two small scratches the full length of the receiver blank. These two lines are still necessary for clearance so don't over look this step.

Now when you push the broach through the receiver it is going to require that you use a fixture or an adapter to make the transition through the receiver, DO NOT stick some damned little piece of scrap metal on top of the broach and continue, this is very dangerous, and could become a lethal projectile.

If you find it difficult to press the broach through the receiver once it becomes flush with the top, then I suggest you make a holding fixture. The fixture that I made fitted over the push rod of the press.

I took a piece of round metal stock about 3 inches long, that was larger than the push rod. I then bored a hole half way through. I then flipped it over and drilled and tapped in the center for a 3/8 inch grade 8 bolt.

What I now have is a piece of round stock with a hole half way through it and a 3/8 inch threaded hole in the center of the solid bottom. Next I drilled and tapped a hole in the middle of the top (bored) half for a set screw. This screw will be used to attach the fixture to the press.

After attaching fixture to the press, I now screw a short grade 8 bolt with the hex head cut off into the fixture and push the broach down until it becomes flush with the top of the receiver.

I then continue by screwing longer bolts into the fixture until I push the broach through.

The fixture that I described works for me on my press. I strongly suggest that you come up with a safe way to push the broach through the receiver before you begin broaching.

Normally A push type keyway broach is used for only a short distance and is designed to pass through the object being broached before it becomes flush.

We are pushing these broaches at their maximum cutting capacity and it will require a special fixture to assist in driving the broaches through the receiver.

I am now ready to begin broaching the raceway of the receiver. I place the thin sleeve in the receiver blank. I center the slot of the sleeve with the slot in the receiver. It's very important that you get the sleeve centered in the receiver, remember the slot in the sleeve is 3/8 inches wide and the slot in the receiver is 7/16 inches wide.

I insert the broach with no shims into the sleeve and press it through the receiver. To help the broach pass through the sleeve, I smear a small amount of white grease on the back of the broach.

I now reinsert the 3/8 inch broach into the sleeve but this time with a .020 thousands shims. Again I press the broach through the receiver. I repeat this process adding .020 of an inch shims with each pass till the broach just cuts a clean groove through the receiver. The last pass with the broach should stop cutting just before it begins to cut into the area bored for the barrel.

I like to bore the hole for my barrel opening around .990 inches in diameter. This allows me to use the diameter of the bore as a gauge to determine where I should stop broaching.

You should now have one groove 3/8 inches wide the full length of the receiver. I now insert the 7/16 inch broach with the back that I ground to 3/8 of an inch into the slot in the receiver.

The slot in the receiver will now act as the sleeve to guide the broach through the receiver cutting a pararallel groove directly opposite the first groove. Once you have made the first pass with the 7/16 inch broach you will need to add shims, .020 thousands of an inch thick, one at a time just like you did with the 3/8 inch broach.

Now at this point you should have a receiver blank with one 3/8 inch, and one 7/16 inch groove cut parallel to each other. The next step is to widen the 3/8th of an inch groove to 7/16 of an inch, using the other 7/16 inch broach that has the back ground to 7/16 of an inch. I follow the exact steps as before using the 7/16 inch groove as a guide, adding shims with each pass until the maximum depth of cut is made.

I now add one more unconventional wrinkle to the mix. As I stated earlier I had originally ground a broach to cut the arc of the diameter of the bolt lugs. I believe this is a waste of a good broach, because I found that I still had to do some file work for the bolt lugs to properly fit.

What I do next is to save time filing. I want to remove material from the center of the raceway groove that was only cut with a 7/16 inch broach. I insert the sleeve into the receiver along with the 3/8 inch broach. To this I add the maximum amount of shims needed for the 3/8 inch broach to cut too its maximum depth.

I then press the broach down and through the receiver. When I am done I will have a receiver blank with two parallel grooves 7/16th of an inch wide full length of the receiver.

At this point your receiver blank should look like the picture above. Now I know what you are thinking I leave the receiver raceways square. The answer is NO I do not, when I am finished the raceways will have an arch very close to an actual Mauser receiver.

The first time I tried broaching a receiver, I thought I was going to break the broach. That's when I realized I needed to make the passes through the receiver without the sleeve, plus grind the leading edges of the broach for clearance.

I am confident that if you make the sleeve properly, and grind the broaches properly that you will be able to broach your own bolt action receiver.

Some might be wondering how many receivers the broaches will cut. I believe that my set of broaches will probably cut 35-50 receivers. I was very careful when I ground my broaches, making sure that I did not get them to hot and change their hardness. I believe that if you do the same your broaches will last for many, many receivers.

Let the Milling Begin!

To start milling the magazine opening I place the receiver blank on the milling table. I then place a level on the rear tang and bring the receiver blank tang to a level position and then secure the receiver to the milling table using standard holding fixtures.

For this to work the cut for the receiver tang must be straight.

Notice the scribe marks on the receiver; those are used as reference lines for milling.

They were made after the receiver was painted in lay out dye on the lathe using the point of a cutting tool.

The power to the lathe was turned off and the lathe rolled by hand

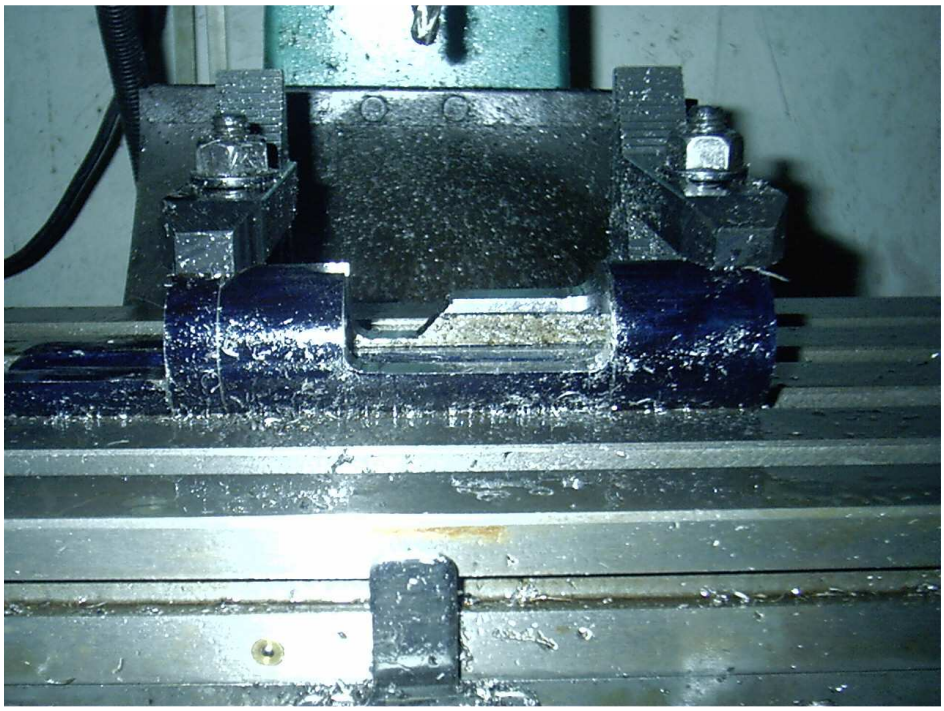
I like to paint the receiver blank with blue layout dye and using the measurements from drawing #1 mark the front ring, rear ring, magazine opening and the rear area of the receiver just before the tang.

I may have jumped ahead just a bit. You will notice that one side of the receiver has been removed, thus forming the tang. I like to cut this piece off using a band saw. It can be done on the mill or with a hacksaw.

I begin milling out the magazine opening using a cobalt or carbide 3/8^{ths} or ½ inch end mill. Do not over cut; start in the center of the receiver. The left raceway has both the thumb cut and a raised area that comes up to the edge of the bolt.

The way that I determine this cut is by looking down bore of the receiver. The raised area is equal with the top of the raceway. The right opening stops approximately .030 of an inch above the bottom of the raceway.

Once I open the magazine opening with preferred 3/8 inch center cutting end mill, I switch to a ½ inch cobalt Ball type end mill to cut the profile at the edges of the magazine opening. (Look at the picture)



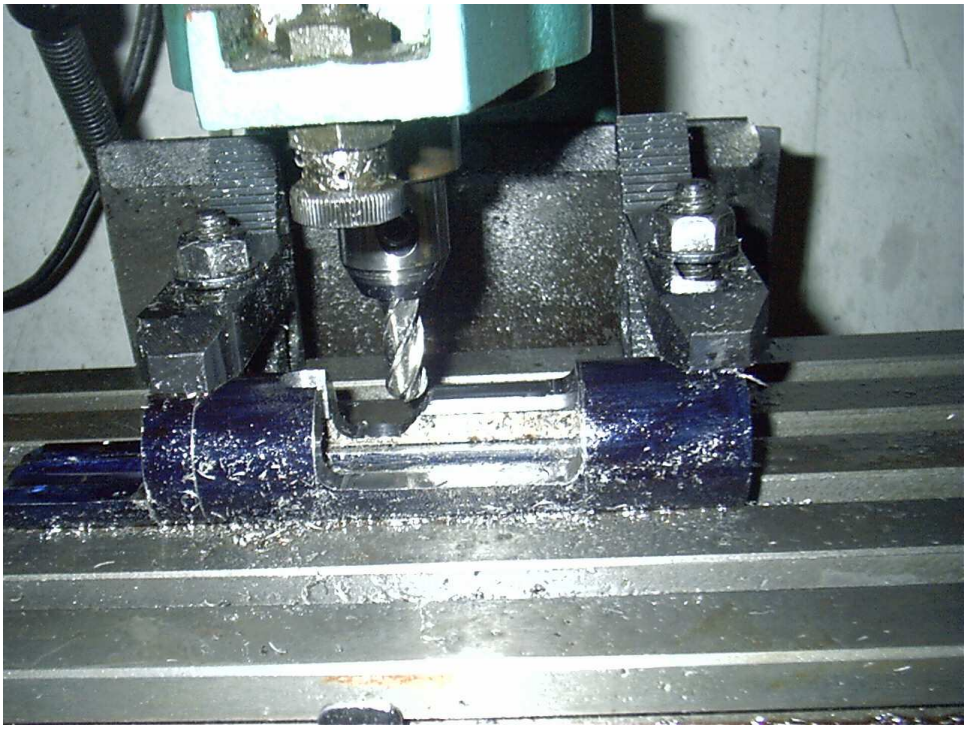
The old saying is that a picture is worth a thousand words. I have found that when it comes to making some of the cuts on the Mauser receiver, this old saying holds true. Study the picture, before you make your cuts

While the receiver is still mounted on the table I make the thumb slot cut with the same ½ inch Ball end mill that I used to cut the profile of the magazine opening.

I start cutting the bottom of the thumb notch at the bridge end of the magazine opening and cut forward, toward the barrel end for a total length of .700 of an inch. I then raise the Ball end mill about .100th of an inch and continue cutting upward until I lengthen the thumb slot to an overall length of 1.125 inches measured at the very top of the thumb cut.

The bottom of the magazine thumb slot starts about .030-.050 inches above the top of the lower left raceway. After cutting the thumb slot I side mill a notch .325 inch long at top dead center for the charging clip. Use plenty of cutting oil and go slow.

If you don't get the profile of the thumb slot just right you can finish with a file. My first receiver thumb slot looked ugly, but several receivers later I could cut the slot free hand with the mill. So don't get discouraged if everything doesn't come out perfect the first time. Find out what works for you at your skill level and go for it.

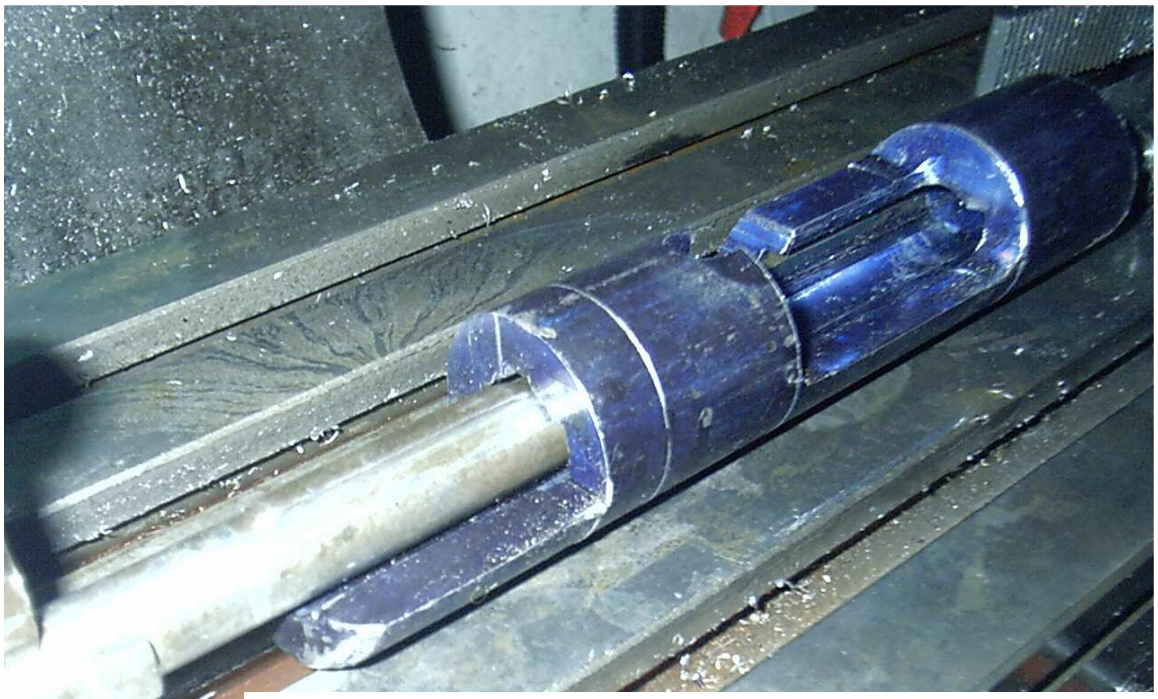


The next step is done by hand. I take the receiver off of the mill and place it in a vise. I take the half round file that I had cut down earlier to a width of .433 inches and file the square ends of the raceways to a slight arc that will allow the bolt without an extractor to enter into the receiver.

Now don't over file, the amount that needs to be removed is very little. The round side of the 12 inch half round file closely matches the arc of the bolt locking lugs.

I have been asked why I mill the thumb slot in my receivers. I do it for two reasons first I like the thumb slot and second it removes a lot a material from the left raceway and makes filing the raceway arc easier.

I next insert the bolt into the receiver. The bolt will enter the receiver up to the bolts guide rib. I mark the guide rib with a scribe. I then use these marks as a guide to broach the slot for the raised bolt guide rib.



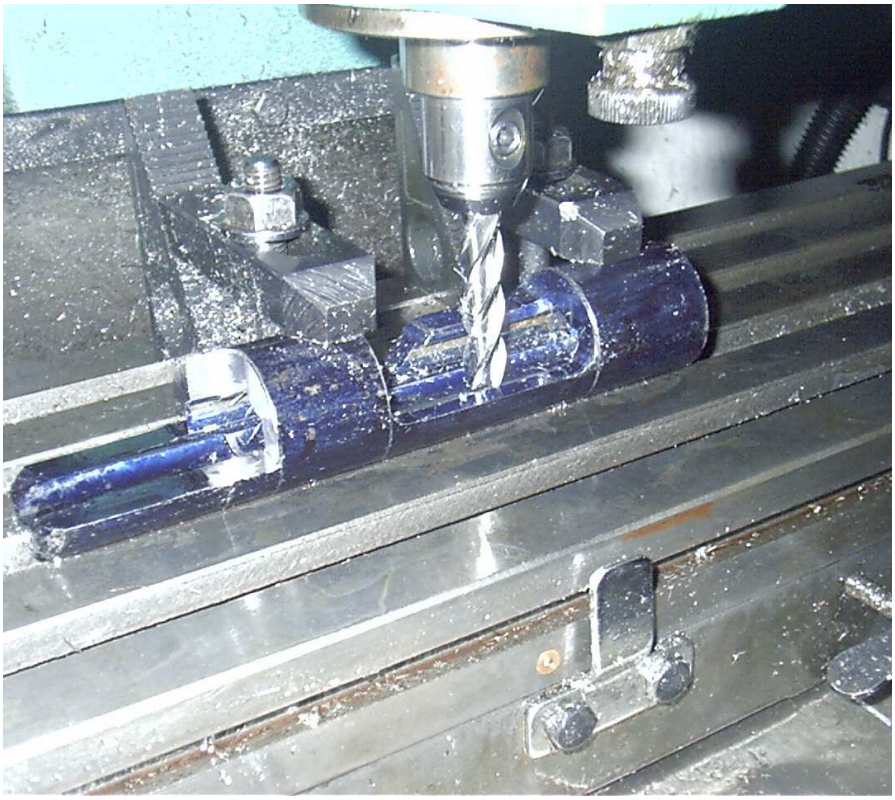
I placed the receiver on the milling table to take the picture.
Do your filing with the receiver held in a vise. Only remove the amount of material necessary for the bolt lugs to enter the receiver

You may find that the bolt has trouble entering into the receiver; you may need to remove some extra material from the right side of the receiver raceway.

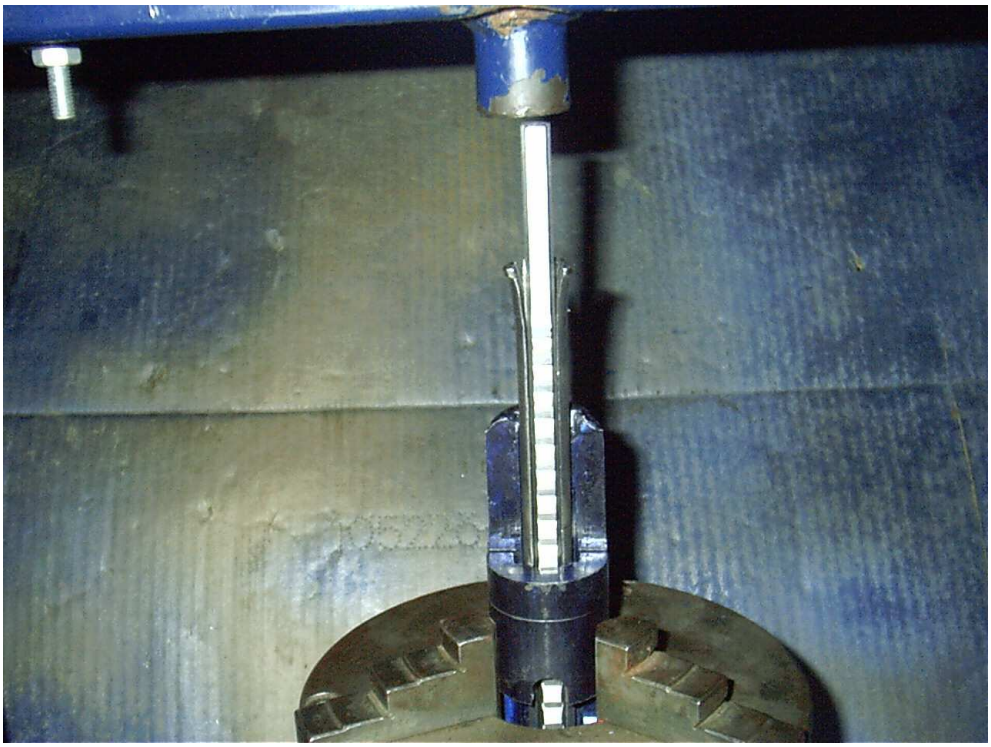
When I was making my receiver I found it hard to file the short lip on the right side of the receiver. The right side raceway is wider on a Mauser style receiver because of the width needed for extractor clearance.

You can put the receiver back on the milling table and remove a slight amount of metal with an end mill from the magazine opening. On my receiver I removed .045 inches from the opening. This cut down dramatically on filing.

What ever you do keep the end mill off of the flat area of the raceway.



I now take the receiver and place it back into the 3 jaw chuck on the 20 ton press. I insert the sleeve and the ¼ inch “C” type broach in the bridge end of the receiver, aligning it with my marks

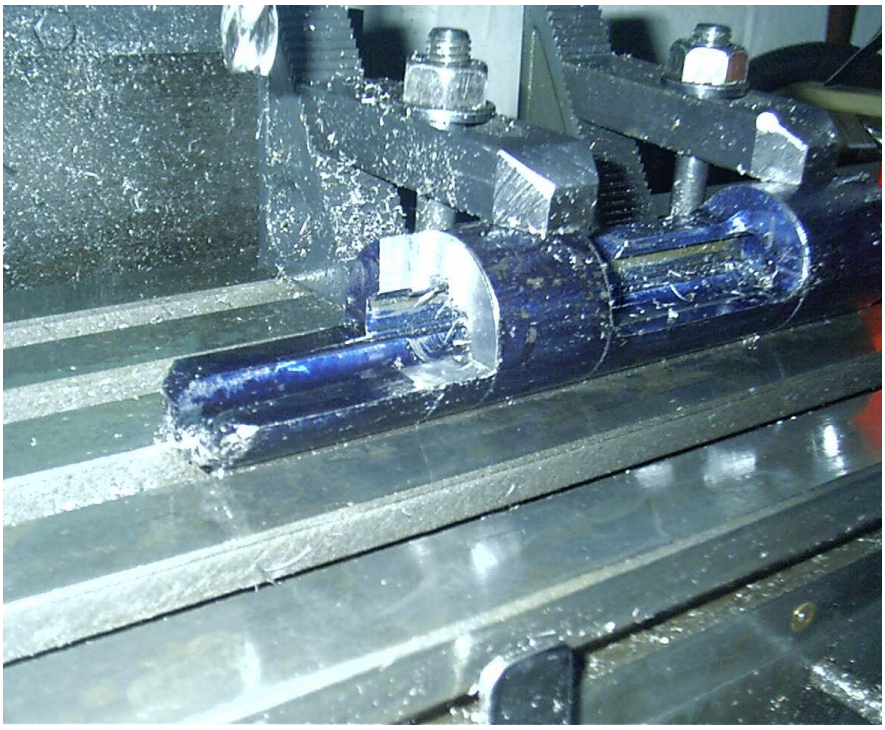


The bolt guide slot is broached very similar to cutting the 3/8 inch slot, the only difference is that you can not push the broach all the way through. You must stop the broach before it gets into the front ring, if it gets in the front ring it can damage the locking lug area, so be careful.

Once you reach the maximum length that you can broach, you will have to press the broach backwards out of the receiver. Do not try to drive the broach out with a hammer and punch, it may damage the broach. The bolt guide rib is not that tall so depending on the exact thickness of your shims it may only take one or two shims to reach the full depth needed to cut the groove.

After I finish broaching the guide rib groove I place the receiver back in the vise and again file the raceways until the bolt enters into the receiver until the bolt handle touches the breach end of the receiver. I then very carefully mark the left side of the bolt handle. This mark will be the guide to mill the notch for the bolt handle to set in the receiver.

I now place the receiver back on the milling table in the same position that I used to cut the magazine profile. Using a 3/8 inch center cutting end mill I cut the opening for the bolt handle.



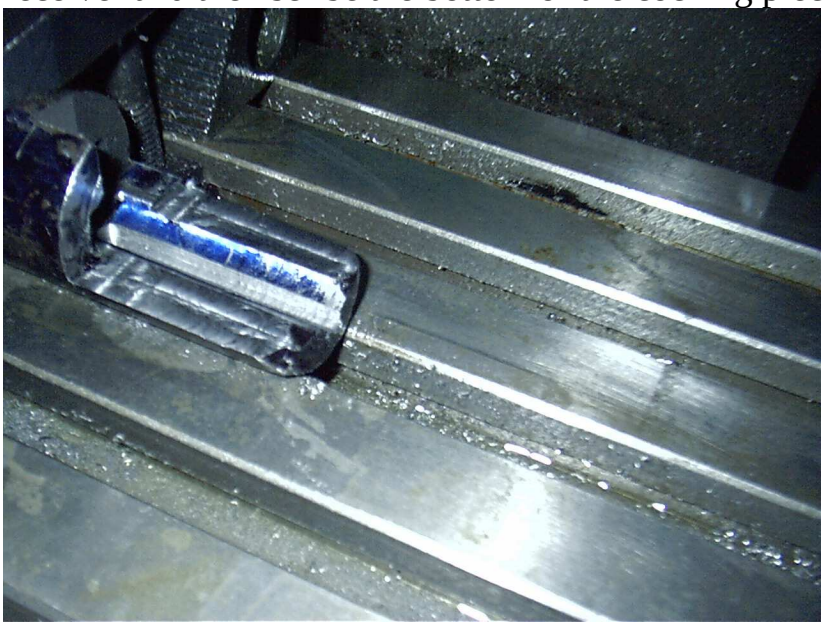
I now have one of two choices to make. I can either cut the groove for the cocking piece or go to the lathe and turn the eccentric notch for the safety lug. Since I know the length of the cocking piece groove to be 2.375 inches, I will go ahead and mill it now.

To mill the groove I use a long ¼ inch center cutting end mill. The first cocking piece groove I ever tried to mill I broke the end mill. You can put a lot of stress on that little end mill so go easy and use plenty of cutting oil.

The sear opening is also made in the cocking piece groove, but I will leave that for a later operation. I will mill the cocking piece groove to a depth of .160 inches. Please remember that the dimensions that I give are for my receiver and my parts.

Not all Mauser parts measure the same. A fool proof way to get the proper depth for the grove is to wait till after you properly cut the tang to height and then install the bolt sleeve assembly into the bolt and insert it into the

receiver and then scribe the bottom of the cocking piece.

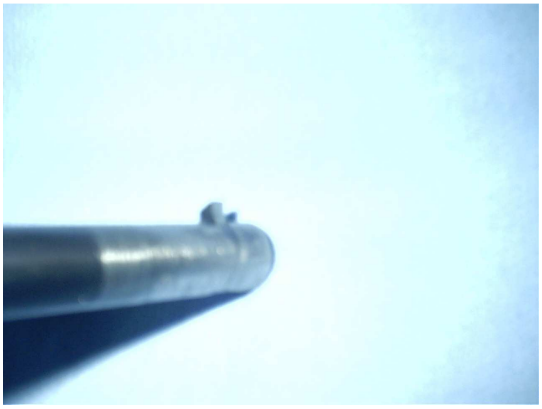


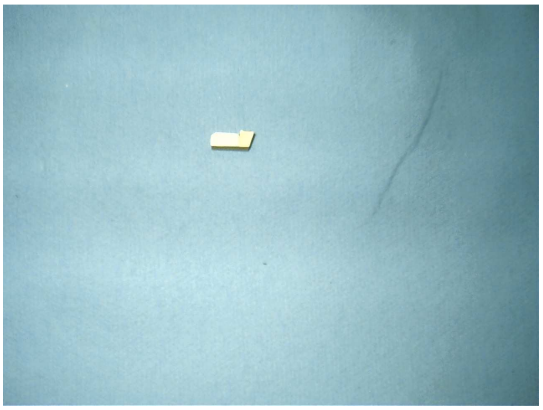
When ever you decide to cut the cocking piece groove this is how it will look. This picture also shows the rear tang reduced in height by approximately .060 inches, leaving the area directly under the bolt handle a the original height.

Now comes the part that everyone dreads, cutting the opening for the third lug or safety lug. I use a ½ inch boring bar and a 3/16 inch square cobalt tool bit blank that I grind to proper shape, mounted in the lathe.

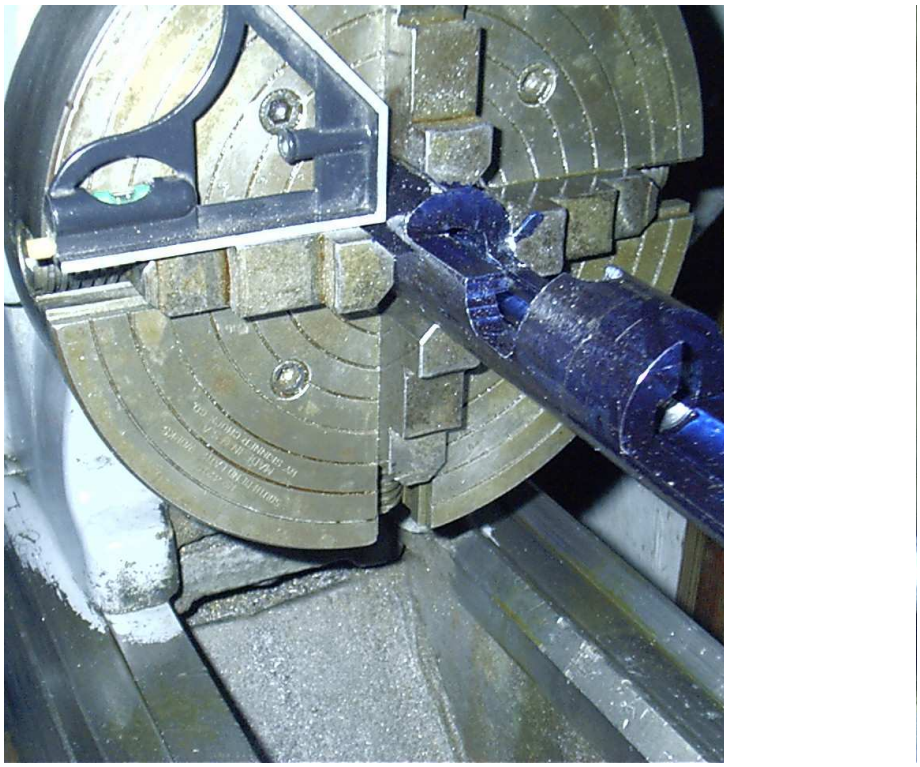
To make an eccentric cut will require a 4 jaw chuck with independent jaws. The chuck must also have a hole large enough for the receiver blank to set in to and still move up or down.

It will also require a small level and a dial indicator with an appropriate magnetic base holder.





The picture on the left shows the shape of the cutter that I ground. The picture on the right shows a picture of a cut off tool replaceable cutting bit that I used as a pattern to grind my own cutter.



The above picture shows the receiver mounted in the chuck with the 4 independent jaws. The level is to help determine the proper position of the receiver when I start to set the receiver for the eccentric cut.

Notice the position of the chuck in the picture and how the receiver is positioned in the chuck. Think of the 4 jaw chuck as shown in the picture as having two planes, one vertical and one horizontal.

In the picture the receiver raceways run along the same horizontal plane as the horizontal jaws of the chuck. I use the level to level the chuck and to level the receiver.

To level the receiver I place the level on the receiver's tang. At the same time I make certain that the receiver is centered in the lathe chuck. To center the receiver you will need to use a dial indicator with an appropriate holder.

Before you can continue you must have the receiver properly positioned in the lathe chuck. In the picture you noticed how the top of the receiver was on top; I now want you to rotate the receiver 180 degrees thus putting the receiver in an upside down position. If the receiver is centered in the chuck the readings on the dial indicator should remain the same whether the receiver is upside down or upright. Now if your readings are off only .001-.003 thousandths of an inch this is not enough to change the eccentric cut.

To set the receiver to make the eccentric cut the bottom of the receiver, which is now on top, will now need to be moved down .130 inches. The movement of the receiver is along the vertical plane. Now as you move the receiver down the horizontal readings will change slightly, but DO NOT try to make adjustment until after the receiver has been moved down .130 inches.

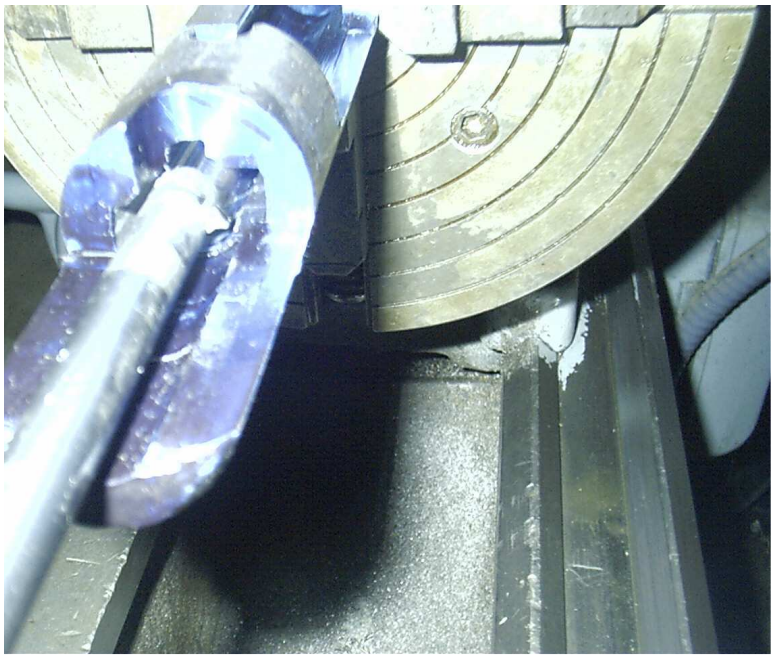
Now I address the horizontal plane, both sides should read the same, adjust the jaws accordingly. Now unless you have never worked with a 4 jaw independent chuck before, setting up for an eccentric cut is not rocket science. With the receiver properly placed and tightened in the chuck, when you rotate the receiver the readings on the horizontal plane should be the same or within a couple of thousandths. The readings for the vertical plane should be .130 of an inch different, if not make the adjustments to correct the readings.

To cut the eccentric slot in the receiver I use a standard ½ inch boring bar and a 3/16 inch bit that I grind to shape. The way that I use the boring bar, is to insert the bar with the tool bit in a horizontal position into the receiver. The tool bit is used like a grooving tool; you make a plunge cut until you reach maximum depth.

Now you are only cutting a groove in the lower half of the receiver, if your

set up is loose, and you don't provide proper clearance for the receiver to move around the tool bar, the bit will catch and you will end up with a full circle groove cut in the receiver.

To determine the placement for the cut I measure from the contact area of the front locking lugs to the front and rear of the safety lug.
I like to lay a dial caliper in the receiver bore with the bottom end of the caliper touching the receiver's lower lug and then mark the location of the safety lug on the receiver with a dental pick.



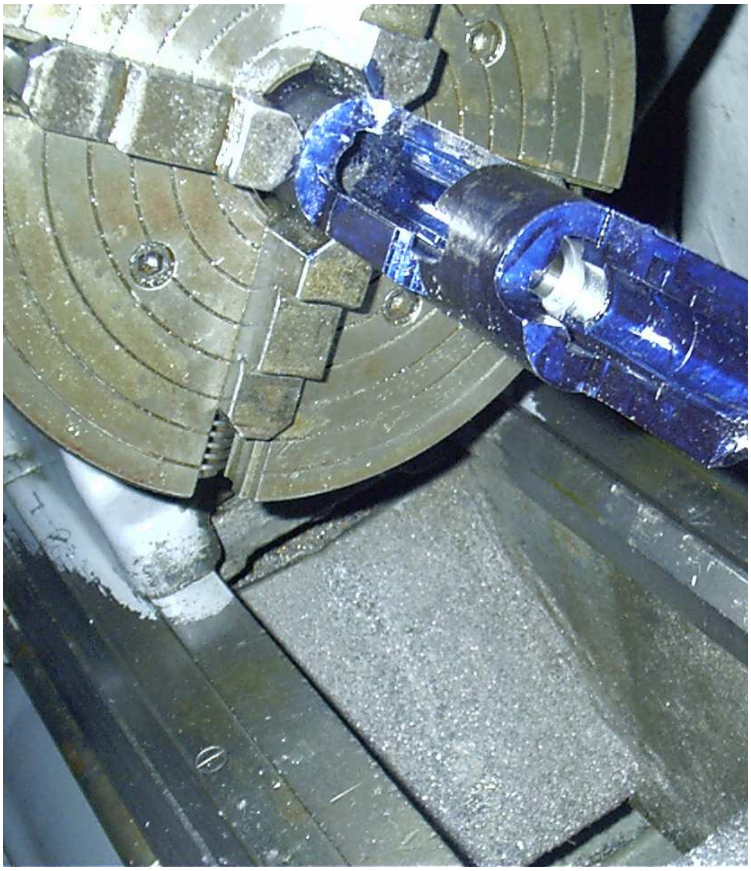
Once I get the boring bar set, I like to rotate the lathe chuck by hand just to make certain I have clearance before I power up the lathe. Hopefully you can see in the picture how I have marked the inside of the receiver for the eccentric turning. The bit needs to extend from the boring bar approximately .140 inches.

There is not a lot of room, you only want to cut the lower part of the receiver, if by accident you get a little metal removed from the top that s not going to effect the performance of the receiver, unless you remove a lot of metal.
If you have trouble check the position of your receiver in the chuck first, is it still approximately .130 inches, also check the length of the bit in the boring bar, adjust it in wards if necessary.

The biggest problem that I had the first time I tried to cut a safety lug slot was lathe speed. I approached it like I was cutting threads with the lathe in back gear, hell every time the receiver rotated around for what should have been a cut the bit was pushed away.

I first thought I had ground my bit wrong, that I needed more relief angle on the cutting face. I was so frustrated I was ready to give up, until I took the lathe out of back gear and changed the lathe speed to 300rpm's, then it cut just fine.

Needless to say the receiver spinning in an eccentric pattern looks dangerous and it can be if you don't have the receiver chucked up tight. Now try different speeds for your turning, 300 RPMs may have worked for me because of the shape of my cutter, yours might be different, so experiment.



This is a completed eccentric turning the little shinny spot in front of the groove is where the boring bar rubbed the layout dye off.

If you find out that the right side of the groove is not cut over far enough to allow the bolts safety lug to enter the groove, you clean up that corner with a rotary tool and a 25/32nd silicon grinding stone. Once the half groove is cut you can deepen or widen the groove if needed with the same sized stone.

Does this chapter seem long or is it just me? There is one more step in the milling of the receiver, its forming the sear pivot lug.

The first thing I do is give the receiver a fresh coat of lay out dye. I then place the receiver top down on the milling table and scribe a line the full distance along the bottom of the receiver at top dead center. I use the rear tang of the receiver as a reference point by placing a small level on flat side of the tang and rotating the tang until level.

That tang sure gets used a lot for reference that's why I said in an earlier chapter to do your best to cut it straight. The line that is being scribed will be the reference point for the hold down screws the sear lug and the center of the magazine, so do your best.

Once I have established a center line down the bottom of the receiver, I then determine the exact position of the sear mounting lug.

In chapter three on Receiver Design, drawing #4, I show a full size Mauser bolt and a measurement of 6.150 inches. This is the length from the contact area of the bolts lug to the contact area of the cocking piece with the bolt in a cocked position as though it's in a receiver with the handle down.

You must have the correct measurement, its possible to get a measurement but not have the bolt handle being in the down position as though it was in a receiver.

Improper sear placement makes for a dangerous condition. On my bolt the measurement is 6.150 inches your may be different go with your measurement NOT mine.

If you are building a receiver to use a bolt from another type of firearm like a Remington or Springfield you must get this measurement correct. Every measurement you take needs to be done correctly, so take your time.

The way that I determine the sear pivot lug placement is by adding the measurement from the cocked bolt (6.150") and the measurement from the receiver face to the receivers locking lugs (1.350") and then subtracting the measurement from the sears contact face to the center of the sear mounting hole (1.320"). The 1.320 inch measurement is from a standard military Mauser sear.

What this gives me is a distance of 6.180 inches. I then measure 6.180 inches from the FACE of the receiver to the point that will be the center of the sear pivot lug. To set up for the machine cut I lay the receiver on its side placing a machinist square against the receiver's tang.

Using my favorite scribe/center finder, I locate the scribe mark that I made earlier for the sear lug, I also mark the width of sear lug on the receiver to be used as reference during milling

I now install a new 3/8 inch carbide center cutting end mill in the mill and make the first of two side milling cuts into the receiver. I align the end mill with the marks for the width of the lug and make a side milling cut.

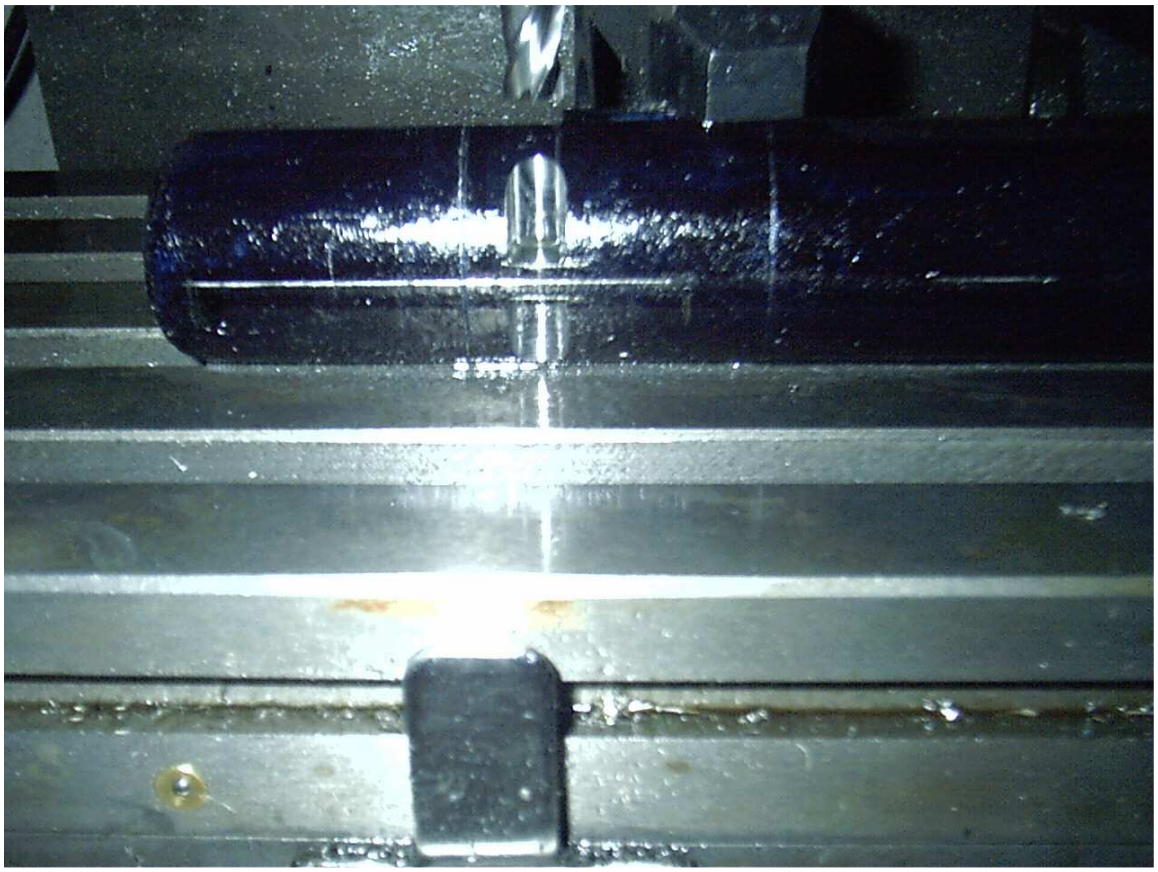
Don’t make a plunge cut here. I bring the end mill to the desired height and just barely let it touch the receiver and then side mill inwards a distance of .340 inches. Go slow and use plenty of cutting oil.

Reverse the receiver on the mill and aligning it on the milling table as before, and make the second cut.

When you mark the lines for the sear lug be as accurate as possible, my sear lug measured .235 inches wide overall or .1175 inches from the center line for each side. The distance of .340 inches is for a piece of round stock that measures 1.750 inches in diameter.

If you are going to make a receiver using my design you can not use a piece of metal less than 1.730 inches in diameter and have enough material to make the front recoil lug and bolt stop lug.

If you are building a receiver to have a flat recoil lug, the metal stock needs to be at least 2” in diameter (preferred 2 ¼ inches). The measurement of .340 inches will have to be increased to accommodate the larger stock.



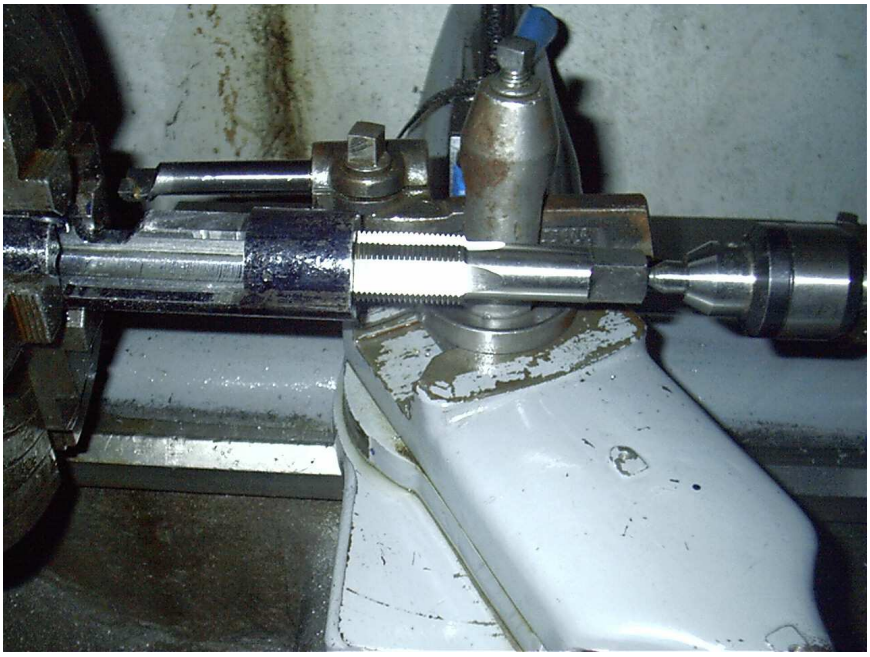
This picture shows the receiver with the side milling cuts. You can also see a faint scribe mark to the right of the machine work, which is the reference line for the sear opening. Remember we measured the sear from the contact area to the center of the mounting hole. The sear contact area is the area where the sear contacts the cocking piece.

Whoops! I thought I was done with this chapter but I have a little more to do.

I now reinsert the receiver back into the lathe, barrel end out. I like to cut the threads on the lathe even if I am using a tap, by hand with power off, it just keeps things straighter.

You can use a 3 jaw self centering chuck for this machine operation or use the 4 jaw independent chuck. I am use to the torture of the 4 jaw chuck and since I'm a perfectionist, I like to keep my clearance levels as low as possible and my 3 jaw chuck can't do better than .0015 inches.

Oh the humanity!



Since I am building to please me and since I broke every one of my cheap ass threading tool bits trying to thread this hard as hell, 4140 pre-hard steel. I decided to thread my receivers for a barrel thread of 1.125 inches instead of the standard 1.100 inches for the Mauser.

Since I had an 1 1/8 inch in diameter, 12 thread/inch tap on hand the decision was easy. Now you can make your receiver anything you want, I encourage you to go with the 1.100 inch barrel threads so you can use over the counter short chambered barrels.

When I talk of barrel thread diameters, I am referring to the diameter of the barrel shank and not the diameter of the receivers barrel bore. A standard Mauser receiver has a barrel bore of 1.00 inches.

Now going with the 1.125 inch barrel shank does give me a little advantage in machine time. Remember that the right raceway on a Mauser receiver is .045 inches wider than the left raceway. The opening for my receiver is 1.046 inches, because I am using a 1 1/8 inch diameter, 12 threads/inch USA tap, this cut's down the amount of material I must remove later for extractor clearance and saves on hand work. Plus cutting with a tap and die is a little more dummy proof.

While I have the receiver chucked in the lathe I also cut the nose of the front ring of the receiver to a diameter of 1.420 inches. A standard Mauser Large Ring receiver has a diameter of 1.400 inches but I want some extra metal for spit and polish.
I cut the nose of the receiver up to the front edge of the recoil lug. On my receiver the cut was .420 inches in length.

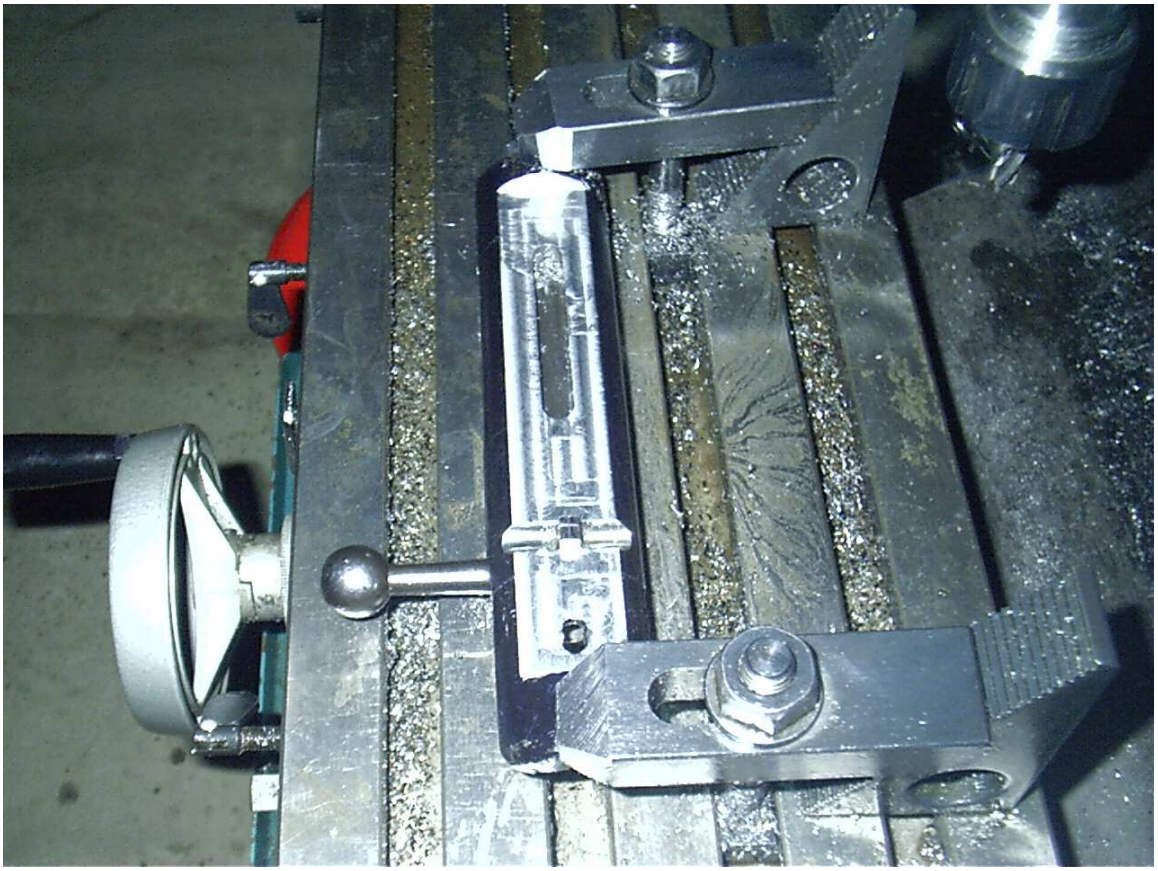
I wait to cut the receiver's nose at this stage for a reason, first I needed the extra full length diameter to assist in holding the receiver in earlier milling and lathe operations.

I make the cut now because it will be used as an index guide for profiling the receiver body in later machining steps, in a similar manner that I used the rear tang.

Chapter Eight

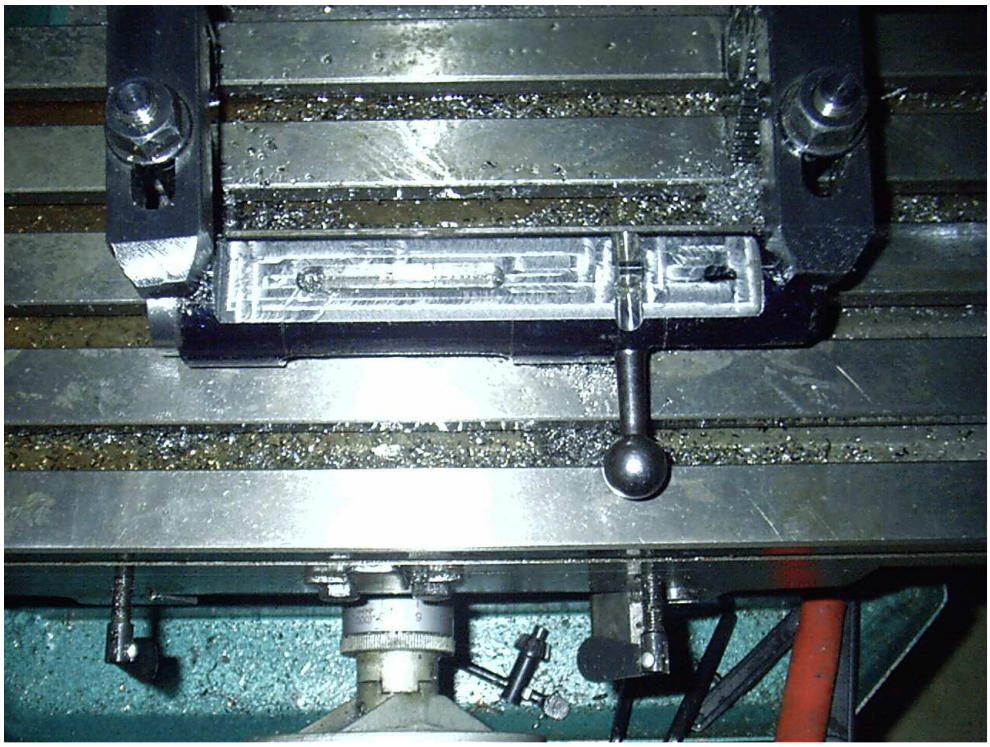
Milling the Magazine Well Opening and Ejector/Bolt Stop Flange

Milling the magazine well opening is not as difficult as it may seem. I start by scribing a mark on each end for the magazine well opening and the sear opening. I then place the receiver on the milling table, with the round bottom up. I place a level against the underside of the bottom tang and bring the receiver to level. Using standard holding fixtures I firmly attached the receiver to the table. Do not over tighten the rear holder; you can bend the receiver tang.



I install a 3/8 inch center cutting carbide end mill in the mill. I mill a slot all the way through the bottom of the receiver at top dead center, inside the scribed lines for the magazine well opening. Do not over cut this slot the hole only needs to be large enough to allow a caliper to pass through to measure the thickness of the receiver bottom off of an installed bolt.

Once I have cut the slot I remove the receiver, and insert a bolt. I determine the amount of metal to remove by measuring off of an installed bolt.

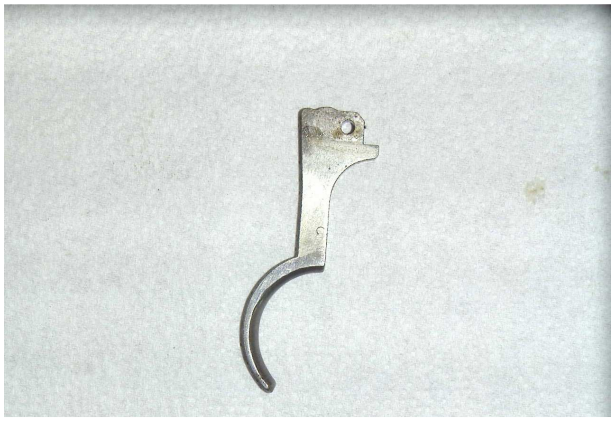


The above picture shows the receiver bolted to the table with the bolt installed. Do not cut this preliminary slot with the bolt installed or you will ruin the bolt. I remove material from the bottom of the receiver, leaving the sear pivot; recoil lug, and rear hold areas alone.

I want to remove metal from the bottom of the receiver until a thickness of .305-.310 inches remain, as measured at the center of the bolt through the preliminary hole on the bottom of the receiver.

I now also mill the sear opening in the receiver at this time, however if this is your first receiver you might want to hold off at this time.

If you do mill the sear opening measure very carefully and remember that the opening will align with the cocking piece groove. An easy way to help locate the proper sear opening is to lay the sear into position, and scribe both ends of the slot. Do not over cut the length of the sear opening the trigger pivots very close to the opening, and an over cut will effect trigger movement.



The picture on the left is a Mauser sear. Notice the raised hump with the hole; this is the sear mounting pivot hole. The raised area on the opposite end is the sears contact lug; the slight inset is the sears contact area. When I measured earlier to get the proper location for the sear pivot lug on the receiver I measured from the sears contact area to the center of the sears mounting pivot hole.
The picture on the right is a Mauser trigger, notice the slight hump just left and above the triggers mounting hole. That area contacts the bottom of the receiver. When the trigger is pulled the rocking motion pulls the sear down thus releasing the cocking piece to move forward in a firing motion. If you over mill the length of the sear opening in the receiver it will interfere with the rocking motion of the trigger. Even if you plan on installing an after market trigger on your homebuilt receiver, you must not over mill the sear opening.

Your receiver is now beginning to take the shape of the Mauser receiver profile. With the bottom milled flat the sear opening cut your receiver should appear as shown in the next picture.

I like to stop for a moment and give my receiver another coat of Blue layout dye, on the bottom, and on the rear near the area of the bolt stop flange.

If you have followed the steps, your receiver should look like the one shown at the side.

Before I begin milling the Bolt Stop Flange or lug, I first must determine if I have enough material on the left side of the receiver to form a lug. One short fall in using a 1.750 inch diameter piece of round stock is that you need almost every thousandth to make this receiver.

To determine that I have enough material I measure the thickness of the left side at it maximum thickness. You must have a minimum .285 inches for the Bolt Stop Lug and .100 inches for the receiver side portion, for a total of .385 inches. Now you can fudge a few thousandths, but no more than .005 inches.

When finished the lug is tapered; with a minimum height of .285 inches on the tang side and .265 inches next to the bolt stop hole. This is needed for the bolt stop to set against the receiver body.

I found that during filing of the left raceway it was easy to remove to much metal not allowing for a usable Bolt Stop Lug to be milled. When you are filing the left raceway as soon as the bolt can comfortably side into the

raceway stop, this should allow you a more than a sufficient amount of metal to mill the Bolt Stop Lug. If you find that you over filed or started with a piece of metal, less than 1.730 inches, you can add metal by welding.

The way that I corrected my receiver was by first wrapping the front of the receiver with wet paper shop towels, and securing it in a vise. I then heated the area until the metal lost its ability to draw a magnet. I held heat on this area for about 5 minutes. Now do not over heat, you can do this with a propane torch or an oxygen/acetylene torch.

If you have never used an oxygen/acetylene torch you may over heat the metal. All you need is to get the metal hot enough for it to loose its ability to draw a magnet, which to me is a dull cherry red.

Once you have reached that point, let it cool naturally in the air, DO NOT dowse in water. This is called annealing, 4140 pre-hard can be annealed, the metal will not be as strong as before, but will still be stronger than normal cold rolled steel.

Now you must wrap the front of the receiver in wet paper shop towels or their equivalent. The front of the receiver must not get hot at all. If you have done this properly you should be able to actually touch the front of the receiver and feel NO heat.

Once the area has cooled to the touch, I weld several passes side by side till I raise the area. I weld this using an arc welder and 1/8 inch, 7018 AC rods. After welding I anneal again to remove stress from the metal, and to remove any hardness that may have occurred from welding. Remember keep the shop towels wet, and let the receiver to cool naturally.

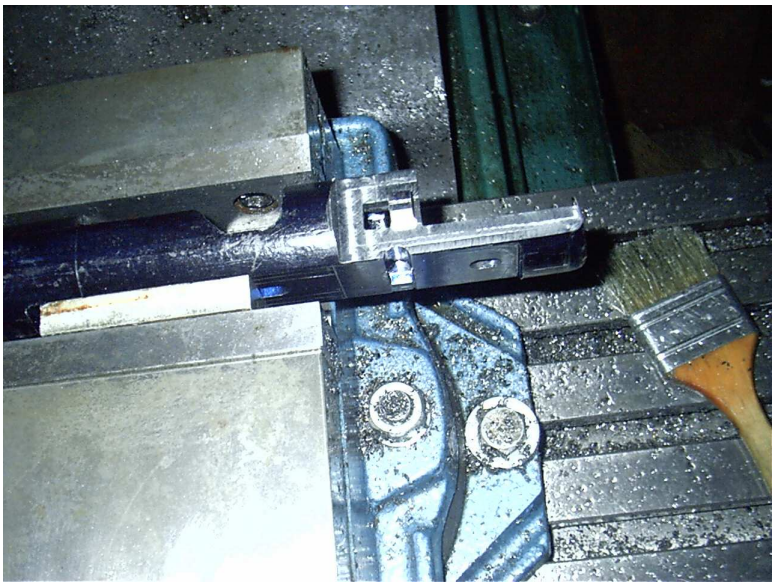
I hesitate to mention that you can weld on a receiver, or any gun part; a lot of good people some times do very stupid things, like not keeping the front of the receiver cool. One other option is to add a small amount of solder to the raised portion of the Bolt Stop Flange (lug) to make the bolt stop set tighter against the receiver body.

Welding can be used to correct many mistakes as long as the mistakes are made in the back half of the receiver, and proper care is taken to keep the receivers locking lugs cool.

I now reinstall the receiver, right side down in the milling vise, for milling the Bolt Stop Flange area. I like to use a small piece of aluminum as a spacer between the receiver's bottom, and the jaw of the vise. You can place a machinist square on the tang, and check for level, but since my vise is of milling quality I just rely on the square of the jaws for holding the receiver in place.

Using the measurements from drawing #3, I very carefully scribe the outline of the Bolt Stop Flange or Mounting lug, including the flat area next to the hole for the bolt stop.

I mount a 3/8 inch center cutting end mill in the mill and begin cutting around the raised lug, being very careful to not over cut. I prefer to leave the receiver thickness around .105 inches, but if needed you can mill down to a thickness of .095 inches. Do not routinely mill the receiver down this thin.



Notice the piece of aluminum being used as a spacer against the bottom of the receiver

When I mill for the Bolt stop Flange I also mill along the rear tang. The square hole was filed square after a round 3/8 inch hole was drilled. When drilling, DO NOT drill into the raceway or you may damage the raceway.

The size of the square hole matches the width of the raceway. I originally was going to buy a special broach to make that little square hole, but after pricing the broach I decided I could take the 15 minutes needed, and just file it by hand.

What I soon realized was that you want to file it by hand if the hole is off slightly you can correct it by filing. I examined some of my Mauser made receivers the holes were rough, in my opinion some of the early receivers my have been filed by hand, so save your money, and buy a small file.

Now comes the fun part milling the actual magazine well opening, and cartridge feed lips. I included in the chapter on design the drawing of the actual template I used to layout the magazine opening.

I again place the receiver in the vise; I very carefully mark the opening for the magazine well. I center template #1 onto the bottom of the receiver in the magazine well opening and trace around the template with a scribe.

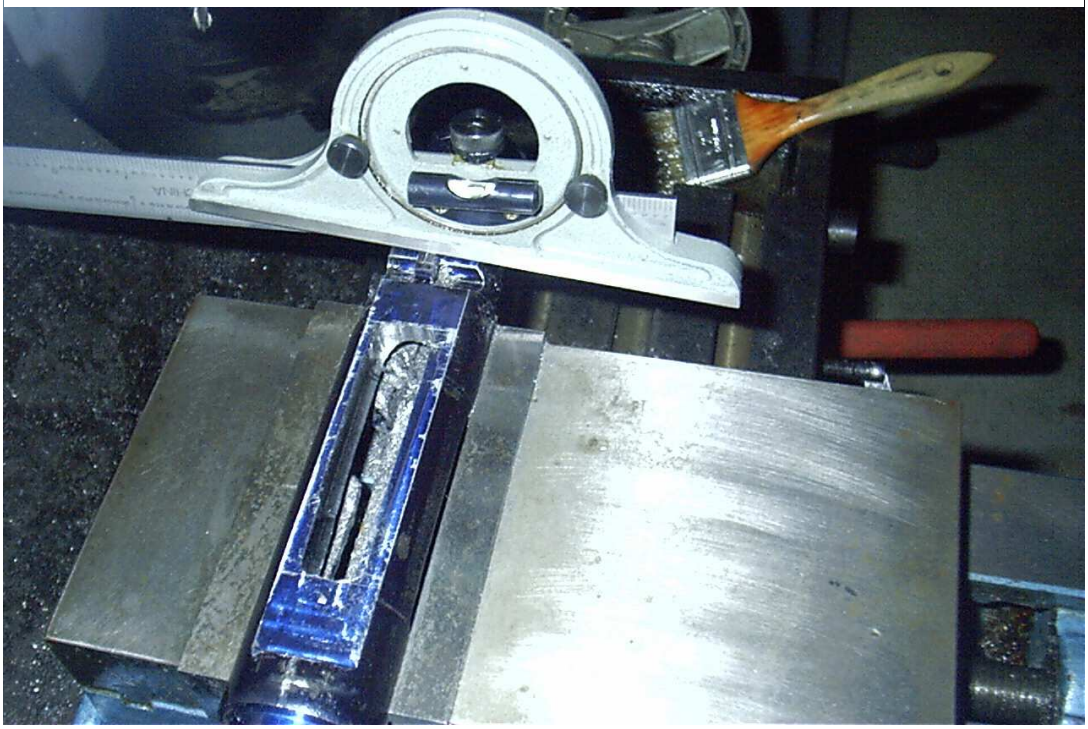
I then center the #2 template over the outlines of template #1 and trace around it with a scribe. These lines will make up the reference lines that I will use as a guide to mill the opening.

First I mill the inside area of template #1 as shown in the picture below. Please notice the layout lines for the magazine well opening as well as the lines of template #2. I use a ¼ inch center cutting end mill for this operation, and cut just to the lines.

DO NOT over cut the inside lines represent the inside measurement of the cartridge feed lips, if any thing mill slightly to the inside of the lines.

My templates are the actual size, and shape that I used to form my magazine well opening, and cartridge feed lips. I made them very close to finished size to save hand work, so take heed.

Next I loosen the vise but leave the receiver in the vise, using a machinist combination square, I tilt the receiver to an angle of 6 ½ degrees.



When you tilt the receiver, you will have a high side, and a low side. Do your milling on the high side. The magazine well is tapered, this duplicates that taper.

The magazine well opening is a taper, and I want to cut a straight line, fortunately for me my milling vise has a swivel base.

I rotate the base of the vise using the scribe lines as a guide so that I can mill the taper of the magazine well opening straight. I have found that the taper of the magazine is slightly over 1 degree.

I like to start milling using a ¼ inch Ball type cobalt or carbide end mill. Because the receiver sets at a 6 ½ degree angle you will remove more metal from the top first, because of this it will be a little difficult at first to judge total depth. If you screw up here you may be finished so start shallow.

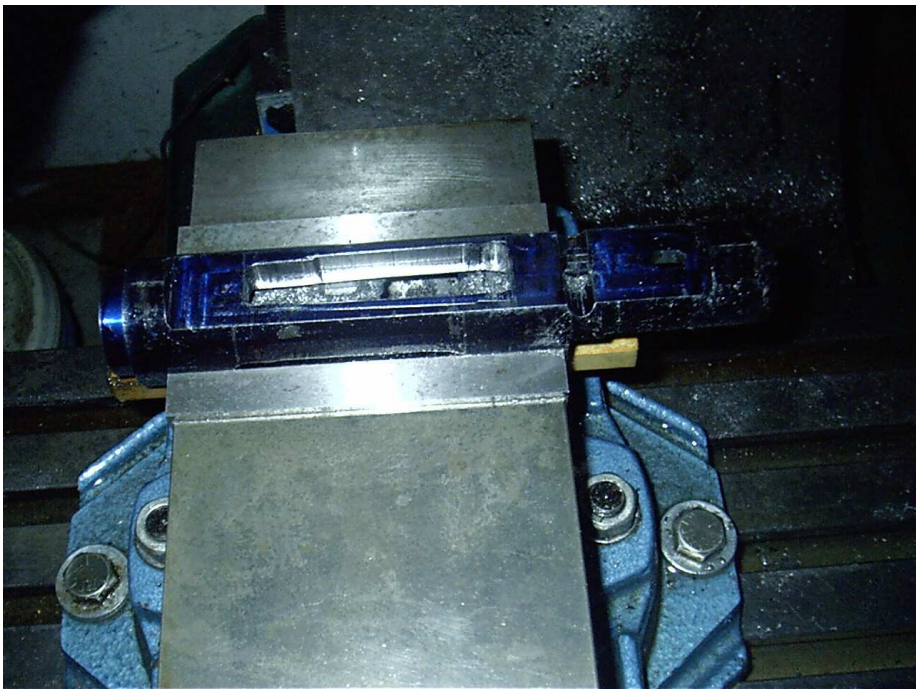
I found that you want to keep the magazine as smooth as possible, and that conventional milling works best. When you are milling just follow the lines.

If at any time during milling you find that you need to reset the angle of the vise, then do so.

Template #2 has a step out about .750 inches from the front of the magazine. I simply side mill to the line and continue milling.

Once I complete the first side, I like to take the receiver out of the vise and then reinsert the receiver into the vise 180 degrees.

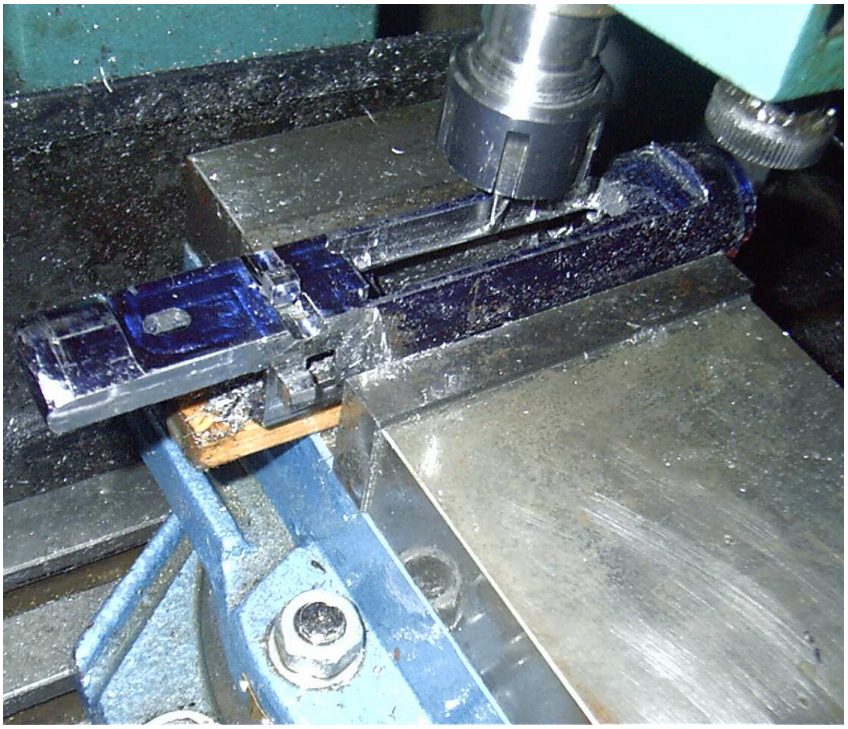
I then set the angle of the receiver at 6 ½ degrees, reset the angle of the vise to correspond to the taper of the scribe lines, and begin milling.



Notice the shape of the magazine that is made by following the scribe lines of template #2. I suggest studying the opening of an actual Mauser receiver before you begin milling

After I have opened up the cartridge feed lips with the ¼ inch ball mill, I level the receiver in the vise, using a level placed on the receiver flat.

I switch to a 3/16 inch ball end mill, and finish cutting the radius, and the height of the magazine lips. Remember to adjust the vise base to the proper angle.



After I have finished putting the final cut on the magazine lips, I take advantage of having the receiver setting flat in the vise and cut the rear hold down lug.

Using the measurement from drawing #1, I mark the hole for the hold down lug. I form the rear hold down lug, and mill the receiver tang flat with a 1 ¼ inch pilot less counter bore.

You must center the counter bore before milling or you will form an off set lug. The 1 ¼ counter bore is a big tool go slow, I use a speed of around 200 RPMs. Use plenty of cutting oil.

The 1 ¼ inch counter bore is a load for a Mill/Drill, you must go slow and use plenty of cutting oil.

When I first started milling the hold down lug I found that it was real easy to start off center. To correct the problem I made a pointed arbor that fit into the hole of the counter bore, that allowed me to align the cutter. Once aligned I then removed the arbor before I began milling

I also drill and tap for the hold down bolts front and rear. Since I am building for myself I use ¼ inch 28 thread socket head cap screws, 7/8 inch long for the front and 1 ½ inch long for the rear. 4140 pre-hard is hard, I use a good USA made HSS tap, and plenty of cutting oil, and I go slow and easy.

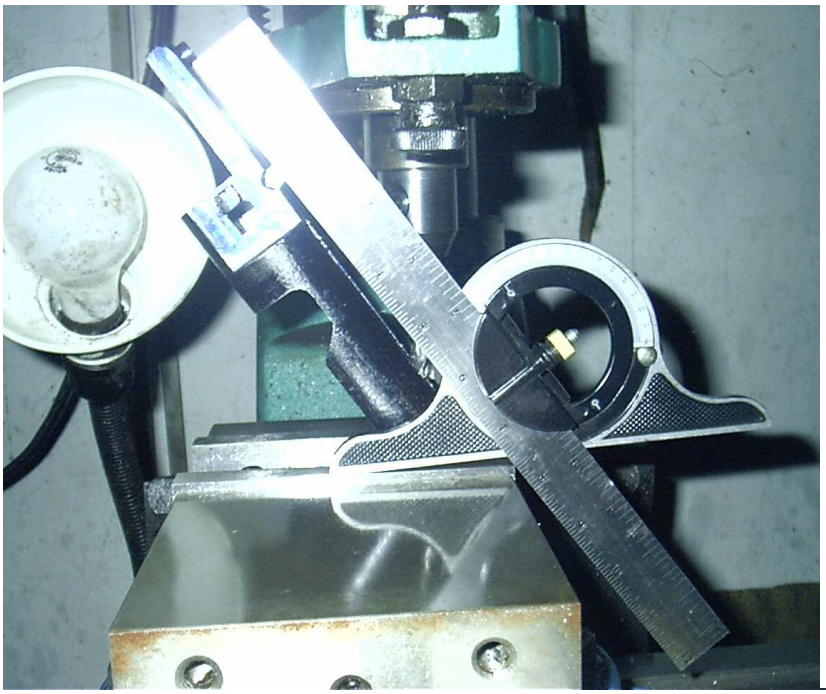
If I were tapping an old Mauser receive I would use a carbon tap, but since this is pre-hard I use the best tap I can find.

No magazine well opening is complete until the cartridge feed ramp is added, that's up next.

The Mauser cartridge feed ramp appears to be made up of many different profiles and therefore very difficult to copy, fortunately that's not true. I start by making sure the vise is set parallel to the cutter.

I then place the receiver in the vise front ring down with the magazine well opening facing the cutter. Using a combination square I set the angle of the receiver bottom to an angle of 55 degrees.

I install an extra long 7/16 inch center cutting end mill in the mill.



The flat bottom area of the receiver must face toward the spindle and set square to the spindles plane. The combination square base sets flat when setting the receiver to angle. When I was taking the picture it kept falling off the vise that is why the base shows a slight tilt.

This shows the end mill at full depth in the feed ramp.

The ramp is cut using the longitudinal feed screw of the mill.

Once to full depth, the bell bottom shape is then cut using the cross feed screw.

You must get the receiver tilt at an angle of 55 degrees.

The end mill must be centered. Do not make a plunge cut, plunge cuts leave grooves that interfere with feeding. Side mill only, use plenty of oil. GO SLOW!

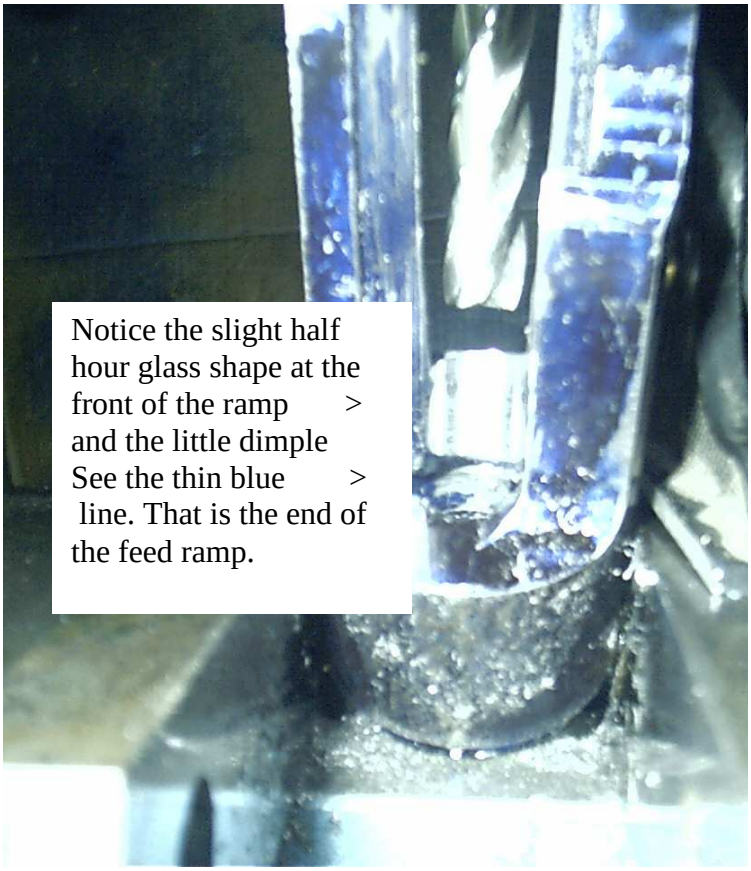
I then center the end mill in the magazine opening, and lower the end mill past the corresponding locking lug; I do not make a plunge cut.

I then SLOWLY begin making a side milling cut into the receiver, using lots of oil. Now make absolutely certain that the receiver is mounted securely in the vise, before you start or you will have a disaster.

I stop cutting just about .030 inches before I cut into the very top of the lower locking lug. The top of the lower receiver lug does not have a groove cut into it, so do not over cut. I suggest that you look at a Mauser cartridge feed ramp before you make the cut on your receiver's ramp.

Once you have made the side mill cut, I leave the mill running, and set the cross feed screw dial indicator to "0", I lock the table longitudinal leaf screws, making sure I have a ridged set-up.

I then screw the cross feed screw inward .070 inches, I return to "0" and, feed outward .070 inches. This creates the half hour glass shape that's the inside of the receiver profile, and also creates the bell bottom shape on the bottom of the feed ramp.



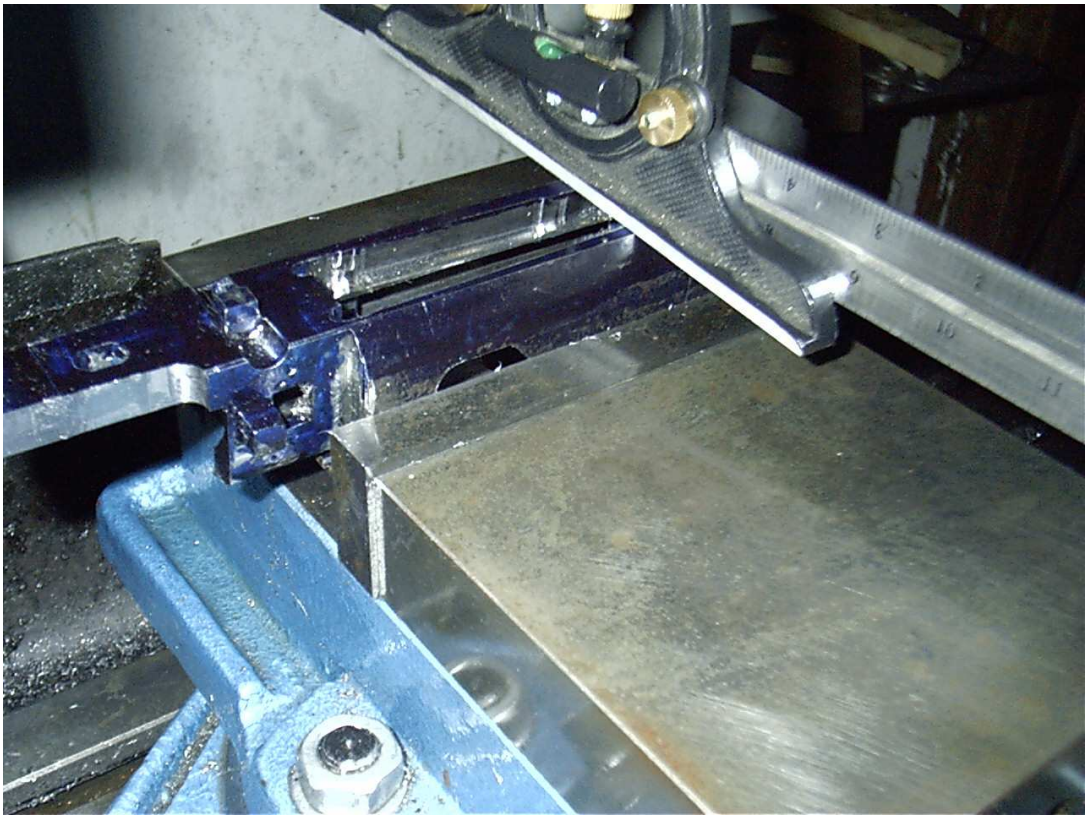
This is the shape of the cartridge feed ramp. It is made by feeding the cross feed screw forward and backwards .070 inches from a center position.

All cutting is made as side milling.

The bell bottom shape can only be cut after the feed ramp cut has been made to maximum depth.

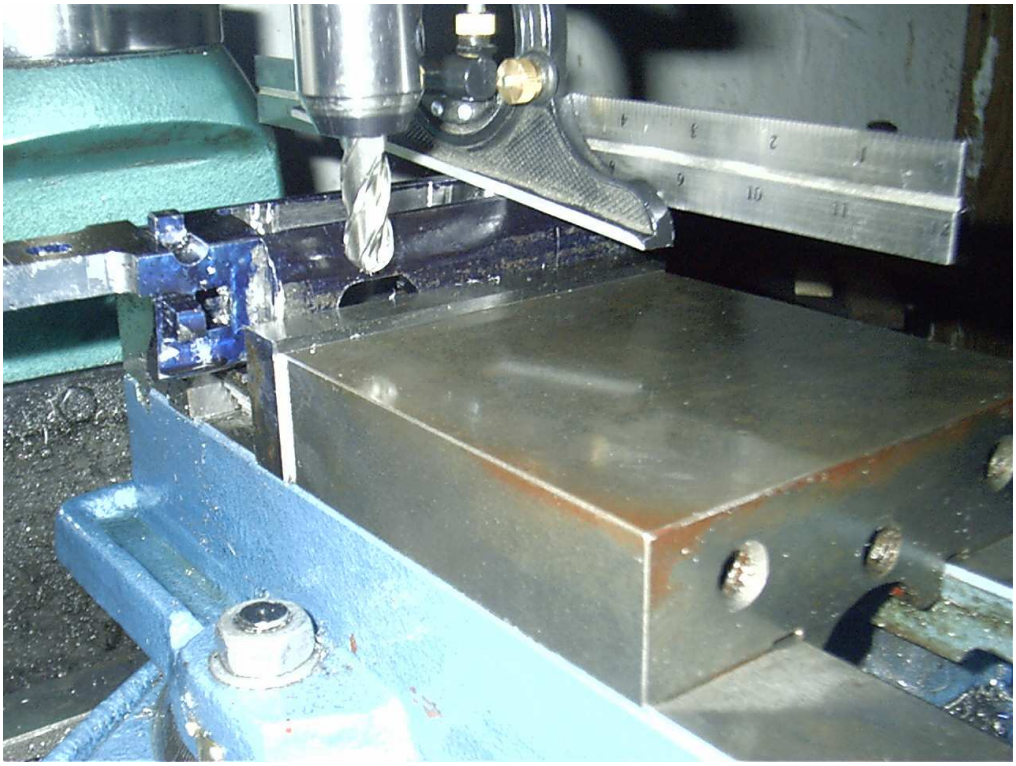
Milling the receiver to Profile

I place the receiver bottom up in a milling vise that has already had the jaws set parallel to the cutter. I place a combination square set to an angle of 5 degrees on the bottom (flat) of the receiver, and tilt the receiver to that angle, and then secure.



I install a ½ inch cobalt or carbide Ball end mill in the mill, and then lower the end mill to the receiver side, stopping the bottom of the end mill about .050 inches above the thumb slot.

I have found that conventional milling works best for these types of cuts. Conventional milling also gives a smoother cut; I found it's also easier on the end mill.



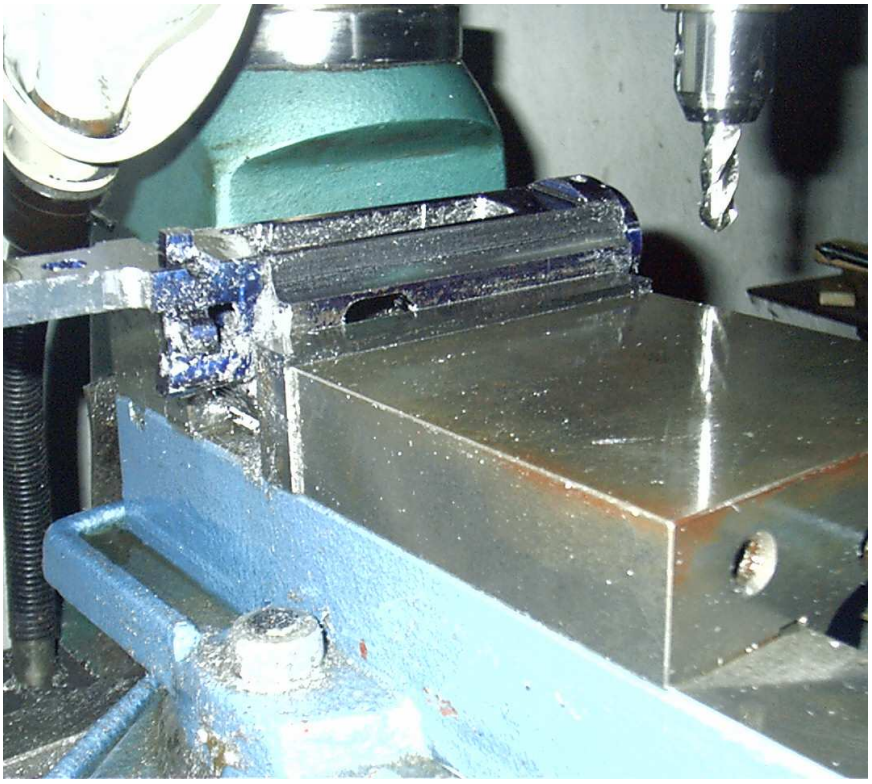
Cut slowly and use plenty of oil. I continue milling until the cut becomes equal the diameter of the front ring. The last few cuts are removing a lot of metal, but don't cut into the front nose of the front ring. Try to make it so your last cut is flush with the nose cut.

If you remember I did leave a few thousandths of extra metal at the nose, but that's for spit and polish not screw-up so be careful.

Some may wonder why I mill a thumb slot, I like using it as a guide to mill the left lower side profile, just another reason I mill the slot.

If you haven't noticed by now there is purpose to my madness of milling certain cuts at certain times in the build process. Indexing off of those features like the rear tang, bottom flat of the receiver or nose of the front ring, this gives uniformity to the build.

Every receiver that I have ever made at first glance mirrors each other, yes there are subtle differences, but they're cosmetic and not functional.



This is how the left lower profile should appear after you have finished the cut. It's very faint in the picture but there is little bright line at the very nose of the front ring, that's the blue layout dye that was removed by the cutter. That how close you need to mill, until you just barely kiss it.

After I finish the left lower profile I then reset the receiver in the vise for the right lower profile cut. I set the receiver at an angle of 5 degrees and secure.

Since I don't have a thumb slot to use as a guide I set the height of the end mill using the right lower raceway. I lower the end .040 inches from the side rail that sets just above the right raceway.

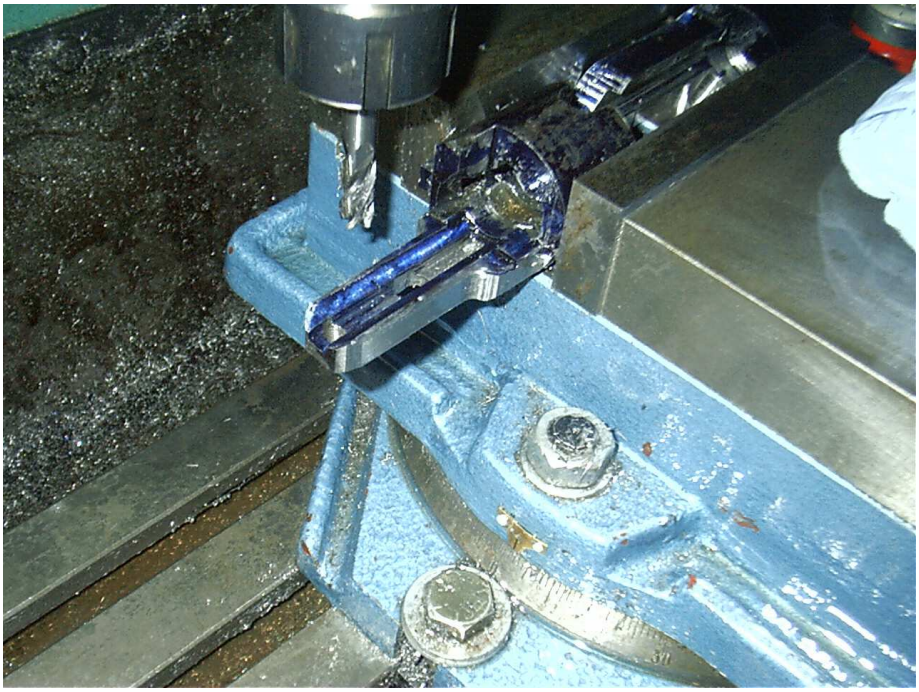
If you over cut the slight raised lip on the top of the raceway, then set the end mill, to where the bottom of the end mill is equal to the top of the bottom of the right raceway.

I have placed forming the rear tang after milling the lower receiver profile. When I milled the rear tang on my receiver I milled it before the lower profile. However you want to do your receiver is up to you. If you follow the steps as laid out in the book you won't have to reset the vise, or even the receiver.

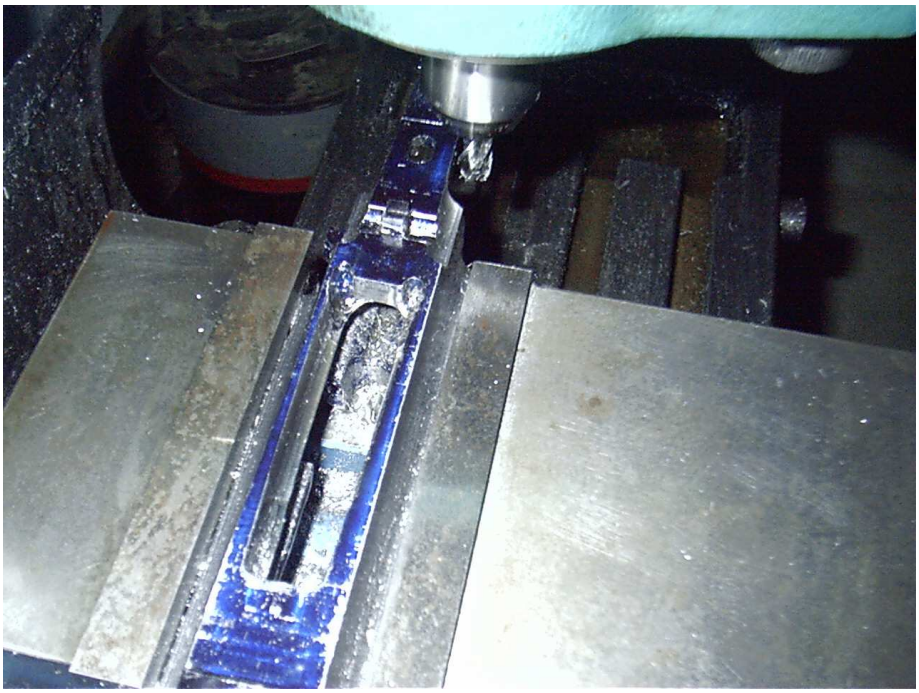
When I milled out my tang I used a template, some how, or another the thing has gotten up and walked out, because I cant find it, but since the rear tang is simple I will just give you dimensions.

The end of the tang measures .560 inches wide just behind the arc on the end of the tang. Then measuring from the end of the tang toward the receiver body 1.940 inches the tang measures .715 inches wide. The receiver tang then arches on both sides stopping at the body of the receiver.

If you have a large ring Mauser receiver, I suggest you make your own template. I do suggest that after you layout the measurements on the rear tang, you rotate the base of the vise so that you can make your cuts straight.



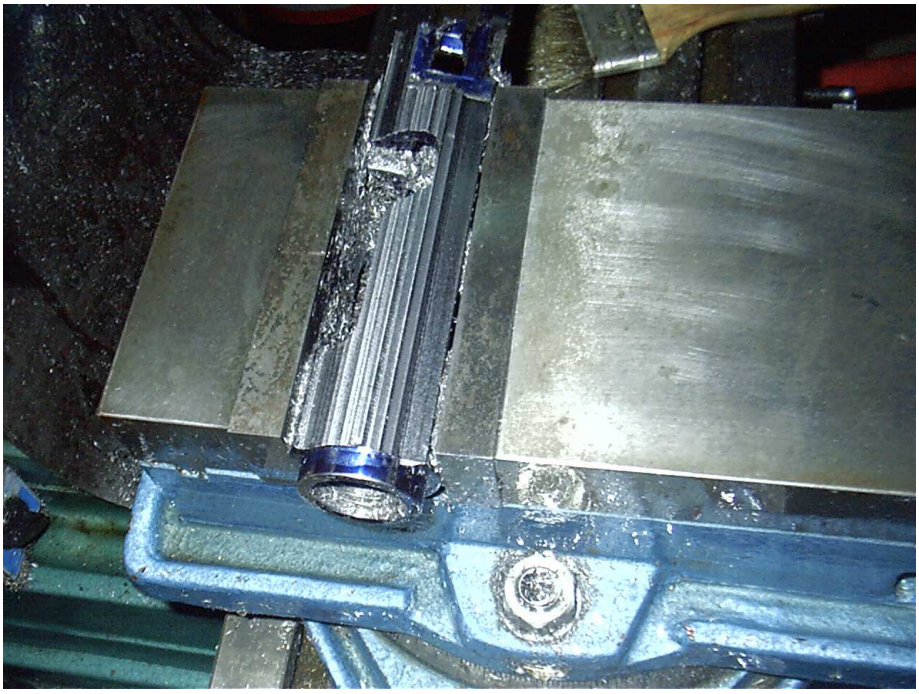
With the receiver still in the vise you can mill the two clearance cuts for the rear tang. I use a 3/8 inch ball end mill for this cut and mill at a depth of .190 inches, and a total length of 1.160 inches. I mill .185 inches into the receiver body.



Final Shaping of the Receiver

To cut the final shape of the receiver you are going to remove a lot of metal. I suggest you use only USA made cobalt, or carbide ball end mills. I use a very good 3/8 inch carbide Ball end mill. I only make conventional cuts and keep the leaf screws tight, any slop in your set up, means a broken end mill. The price of these end mills are not cheap, so take your time and prepare.

I start by placing the receiver on its right side in a vise. I use the front nose cut as reference guide to determine the maximum depth of cut for the 3/8 inch end mill. You will not be able to cut the maximum depth with one single pass. What I do is continue cutting until I get to the necessary depth. Now use plenty of cutting oil, and don't let the receiver get hot.



When cutting I raise and lower the cutter and use the table feeds to make the cuts, and do not turn or move the receiver, until I am finished with a side. Now this does leave the surface very rough.

I remove this roughness in another step with a tool post grinder. It would be possible to mount the receiver on a mandrel, and then place the receiver between a rotary table, and dead center. You would then rotate and move the receiver under a fixed ball end mill cutter. This would provide a smoother finish, and with a little spit, and polish, you could have a finished receiver.

Now I prefer my method because I believe I get a better finish and a more uniformed profile. The diameter of the bridge ring is smaller than the front ring by .100 inches. After I mill a side to the depth of the front ring, I then lower the ball end mill .040 inches, and mill the rest of the receiver behind the front ring.

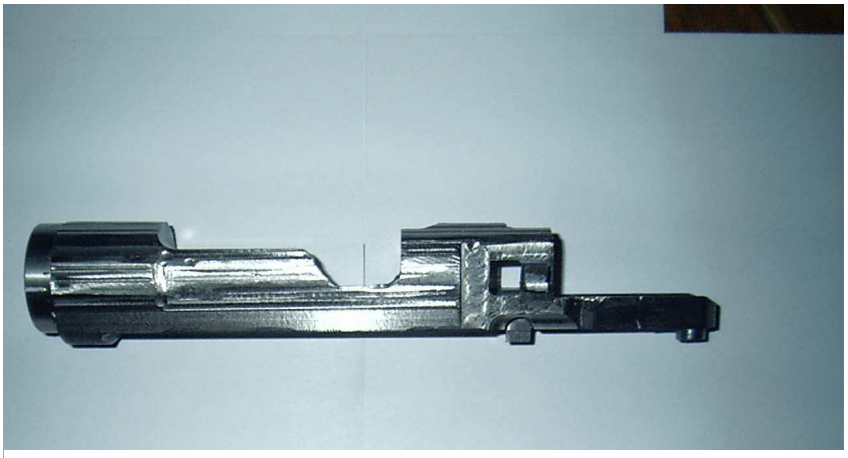
I prefer to only mill .040 inches and use a tool post grinder to clean up the rest. When you get to the very rear of the receiver next to the receivers base, the sides get very thin, so don’t over cut.

After completing the left side I rotate the receiver in the vise and mill the top in the same manner that I milled the left side.

After I finish the top I continue to the right side cutting as before, always making certain not to over cut and using the front nose cut as a guide.

Here is what my receivers look like after cutting with a ball end mill.

This is the right side of the receiver. The rear of the receiver has been milled down .040 inches more that the front ring. Other than final fitting and shaping, you now have a firearm.



This is the left side of the receiver. The area in front of the bolt stop flange must be shaped smooth for the bolt stop to rest properly against the side of the receiver.

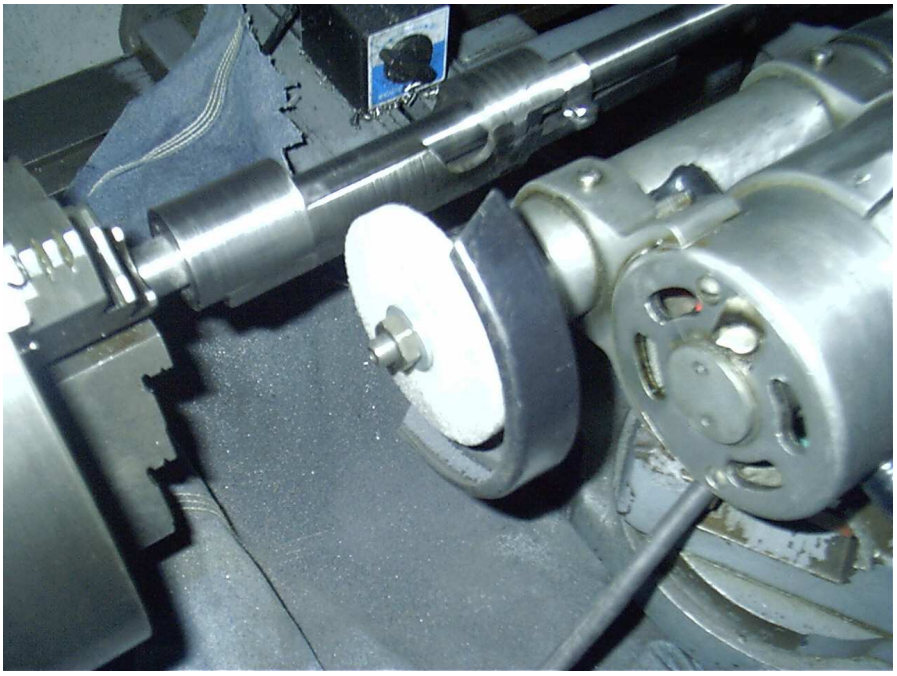
I now screw a holding fixture into the receiver. This holding fixture is nothing more than a 12 inch rod that has been threaded, and turned down on one end to fit into the bore of the receiver.

I attach the holding fixture between the lathes centers; I also attach a tool post grinder to the compound rest of the lathe. I install a white grinding wheel onto the grinder, and then square the wheel to the receiver.

Making certain the power is off on the lathe, I feed the grinding wheel up to the receiver using the compound rest on the lathe.

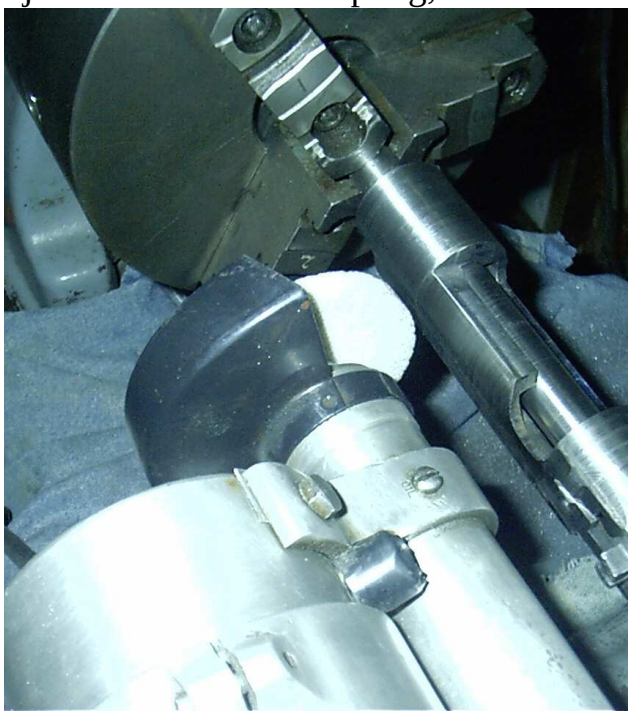
I roll the receiver by hand into the wheel, only removing a few thousandths at a time. Other than the very first pass at the very nose of the receiver, you can not roll the receiver a full circle. You must take care and stop rotating the receiver, before you hit the bottom edge or the wheel will dig into the receiver body.

I make my first pass with the grinding wheel and then move the tool post grinder over half the width of the wheel and roll the receiver again. I do this over the full length of the receiver and continue until I achieve the desired profile.



After shaping the profile of the main receiver body the last pass I make with the tool post grinder is the contour at the bottom of the receiver. I have found it matches the diameter of the 3 inch grinding wheel I use to profile the receiver body.

The tool post grinder can shape the receiver every where, except for a small section just above the bolt stop lug, I finish that with files and a rotary tool.



With the grinding done, I had a finished receiver, but it still looked rough. All of the ridges were gone, the shape was there, but it still didn't look right. I tried to polish the receiver with emery cloth; it helped, but the emery cloth left scratch marks, which required more polishing and elbow grease.

I began looking for a way to make final polishing easier. What I decided on worked like charm, it may not be perfect, but it saved a lot of hand work. I reinstalled the receiver back on the mandrel and attached to the lathe.

Once again I mounted the tool post grinder on the compound rest, the only difference instead of a grinding wheel I attached a rubber abrasive wheel, what a difference.

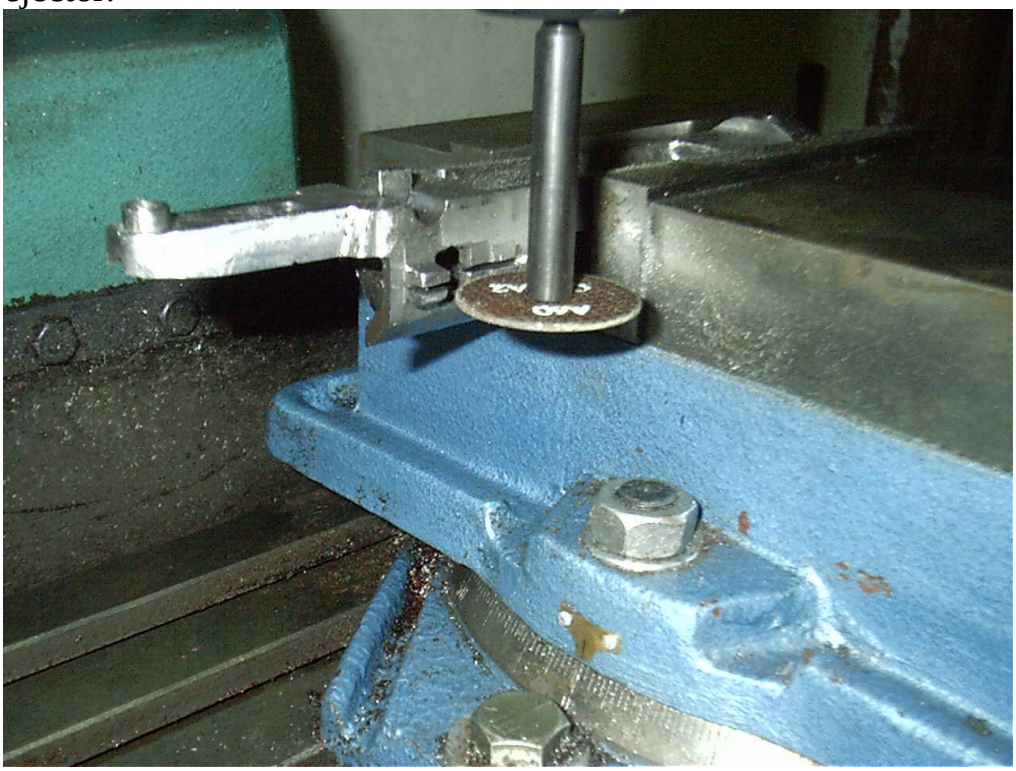
This is a picture of a receiver after grinding. It has the shape but is rough overall. Notice the marks on the lower section of the receiver below the thumb slot, the rubber abrasive wheel all but completely removed those marks.

After I finished the section on grinding the receiver to profile, I realized the need to provide a warning to all those wanting to grind their receivers; you must keep the receiver from getting too hot. I use white grinding wheels, the white wheels do not cause heat build-up like the pink wheels, but they can still over heat the receiver.

The way I counter the heat is by making shallow passes. I don't like to run water over the receiver, fortunately the mandrel acts as a heat sink. So heed the warning, over heating the receiver may cause a dangerous condition

Odds and Ends and Finishing Touches

To cut the ejector slot, I first tried a small HSS keyway cutter, only to dull the cutting edges, practically on contact. I thought about a rotary tool but those small wheels were to narrow, and they broke easily. The third thing that I tried not only worked, but worked so well I suggest you don't waste money trying anything else. I installed a 2 inch reinforced cut off wheel 1/16 inches thick in the mill, and was able to cut the lug and the slot with ease. Before cutting the slot I inserted the bolt, to the bolt stop hole, and used the slot in the bolt lug as a reference to determine proper placement for the ejector.



Mounting the bolt stop/ejector box is fairly straight forward. I use a 3mm drill bit to drill the hole. I found out the hard way that you must drill the hole straight.

I placed the receiver bottom up in the vise on the mill, and squared the receiver with a level in both directions and then drilled the hole.

When I drill the sear pivot hole, I first install the bolt into the receiver in a cocked position with safety on, bolt handle down as though it's ready to fire.

I place a 1/4 inch steel dowel .440 inches long in the sears spring cup, I then place the sear over the pivot lug with trigger installed. I butt the sear, using no pressure against the cocking piece and secure with a "C" clamp. (The dowel rod is used as a gage only and is replaced with the sear spring for final fitting after drilling)

I check the clearance at the edge of the sears spring cup with a feelers gauge set at .070 inches and correct the length of the dowel as necessary with shims to obtain a clearance of .070 inches.

I then place the receiver in a vise and square with a level in both directions and secure. I then drill the hole with a 3mm bit, making certain that the sears contact area is held firmly against the bottom of the receiver.

Just like the ejector/bolt stop lug hole the sear pivot hole must be drilled straight. I all most ruined one receiver because I drilled the sear pivot hole by hand and got the thing crooked.

I was able to salvage the receiver only because I was able to mill the lug and sear hole to .125 inches. Unfortunately you can't do that with ejector/bolt stop lug, so don't screw up.

Notice the position of the sear and how it is contacting the receiver toward the rear of the tang.

It's very important to mount the sear properly, not just for firing but for safety. The area of a sear that contacts the cocking piece has a slight angle; this angle allows the sear to reengage the contact area of the cocking piece if the trigger is pulled slightly, but not to full firing position.

The trigger that I use is a standard Mauser two stage military trigger, that allows for a slight pull of the trigger without firing, if these angles are not laid out properly the sear will not return to full contact with the cocking piece.

Even if you use an after market trigger the sear pivot hole must still be drilled straight, and in a position that allows for proper sear contact.

Another safety check that must be made before installing a barrel or test firing is determining whether your gun will fire on its own.

I start by installing a complete bolt, trigger, and sear on the receiver. Move the bolt into a cocked position and engage the safety. After the safety has been engaged, pull the trigger and release.

Now release the safety, hopefully the sear returned to its original position and the firing pin did not move forward into a fired position.

If the firing pin moved forward into a fired position you have a potential disaster in your hands that you absolutely must correct.

What happened was this, when the trigger was pulled it moved the sear down and allowed the cocking piece to move to far forward, when the trigger was then released the sear could not reengage the cocking piece. That's why the firing pin moved forward simulating the firing of a gun.

Hopefully this can be corrected by some very careful stoning of the sears contact area. Before you remove any metal make certain you haven't mixed up any parts and that you have the right bolt.

If you have all of the right parts and the problem can not be corrected the only solution left is removing metal from the cocking piece.

However, if everything was done correctly removing metal from the cocking piece should not have to be done.

There is always the possibility that you drilled and mounted the sear out of position. If that's the case substantial repositioning or modifying might be needed, I suggest you investigate every possibility before you proceed.

One final touch that needs to be looked at is the fit of the magazine/trigger guard to the receiver. When I milled the magazine well I followed the template a close as I could, but I found that when the trigger guard was installed a small amount of additional fitting may be required.

For the follower to function the receiver magazine well, and trigger guard must fit flush, any amount of metal that can hinder the movement of the follower must be removed. I found that a hand held rotary tool fitted with a sanding drum seems to do the trick.

Notice the thin blue line on the rear section of the magazine well opening, it’s only a few thousandths thick but is enough to stop the movement of the follower. I found that you don’t need to remove a large amount of metal. Grinding the surfaces flush is all that is needed.

I was originally going to include a chapter on barrel fitting, chambering, and head spacing, but there must be a hundred books out there on the subject, and every one of them do a fine job. I have decided instead to only cover barrel fitting to my homebuilt receiver.

Earlier I discussed how I changed the diameter of the receiver to handle a barrel shank diameter of 1.125 inches. I made this decision based on the barrels that I have available and the tooling.

I suggest that you build your receiver to handle the standard Mauser barrel shank diameter of 1.100 inches.

No mater what barrel you use there must be some hand work to allow for extractor clearance between the end of the barrel threads, and the receivers locking lugs on the right side.

I originally thought about taking a small boring bar, and opening up that whole area, but after looking at one of my Mauser built receivers I realized that Mauser milled that area alone.

The easiest way I found to do the job is to take a rotary tool with a grinding stone, and carefully make a pocket area for the extractor. There must be adequate clearance for the extractor or the bolt will not close on a cartridge.

The depth that I used for my receivers front ring bore is 1.350 inches this accommodates the standard Mauser barrel shank length of .625 inches.

One thing that I am a stickler on is head space. I like a very tight head space, and prefer nothing greater than .002 inches.

I suggest every builder that is not familiar with cutting a chamber, and the use of head space gauges, research, and become knowledgeable in their use before attempting to replace a barrel, cut a chamber, or build a receiver.

There does have to be some forward caming action on the locking lugs to aid in chambering. The easiest way to cut the caming ramp is to use a pillar file that has safe edges. The right front lug and safety lug can be reached with a file. The left lug can be reached with rotary tool using an inverted cone grinding wheel. You do not have to duplicate the forward caming action of a real Mauser for your receiver to function properly

Notice the angle of the file. The Mauser feed ramp is more than just a simple ramp, it's a combination of angles that allows the bolt to rotate, and move forward at the same time. Using a file takes time but you can replicate the ramp. Make certain your files have a safe edge. (Non cutting)

I had originally come up with a way to replicate the forward camming area of a receiver using an end mill, but it still required some filing in the corners. It involved some fairly complicated positioning of the receiver and is not worth mentioning. I found that a good file with some patients, and practice did a better job.

I had shown in chapter one a receiver action wrench that was used to attach the barrel to the receiver. You will also need a barrel vise to hold the barrel. I made the vise out of 1 ¼ inch mild steel.

I first drilled two ½ inch holes through both pieces, bolted them together, and then bored a 1.475 hole through the middle. The holes on the outside edges are for bolting to a bench.

You will need to make some barrel bushing. I used a piece of 1 ½ inch round aluminum, 1 ¼ inches long. I drilled a ¾ inch hole in the center, and reamed with a #3 Morse taper reamer. You can also buy a similar barrel vise for less than $75.00 if you shop around on the internet. The choice is yours.

I hope that everyone that reads this book and builds their own receiver, realizes that by building your own receiver you have tremendous control over quality.

This is the top view of a completed receiver.
Notice how close the profile matches a large ring Mauser. Notice the position of the bolt stop ejector box. It's necessary for the bolt stop ejector box to set tight against the receiver for it to function properly. The charging clip slot is cut with a 7/16 inch end mill and completed with a 3/8 inch file. The final shape is cut with a small round file.

This is a general view of the receiver with a complete bolt and trigger guard attached. Notice that I have drilled and tapped the receiver for scope mounts. If you build the receiver properly standard Mauser parts like trigger guards, bolts, scope mounts, stocks, triggers, and sears work. The amount of time, and money that can be saved by using readily available parts is enormous, plus with the over the counter options available makes the home build extremely versatile.

Last view before mounting in a stock

This is the final goal, a shootable Bolt Action Rifle. The stock is an over the counter synthetic stock that is pre-inletted for a large ring Mauser. The barrel is off a 1914 Enfield that was chambered for a 30-06. The barrel has been cut down, rethreaded, and chambered to 308. The barrel was also cut down to accommodate the sights. The sight bases are held in place with a glass bedding compound. The sights are some left over Mauser stuff that I was too lazy to throw away, but hey it works.

Remember, Spread the Word. Share this Book with your friends and tell them, they too can build their Own Personal Use Firearm.

Enjoy!

Chapter Twelve

Final Thoughts

After I finished the receiver I had one fear, had I created a design to complex for the average home builder?

My first thoughts were that I spent 8 years working out my design and build techniques for my receiver and only a very few people would ever be able to build it.
The cost of broaches and machine tools is not insurmountable. No matter what design or type of firearm a home builder makes, there is a cost in machine tools and tooling.
I deliberately used tools in the building of my receiver that are common in most shops. A modest size lathe is required for the eccentric turning, but a $1000 dollar Mill/Drill can be used for all of the mill work.

I do throw in one ringer, a tool post grinder. Yes those grinders are high priced, if you bought a new tool post grinder it would break the bank, but used ones are available. I have seen pictures, and plans on the internet for building tool post grinders in the home workshop, often for less than $100 bucks, so that shouldn't be a problem either.

After the attack on September 11, 2001 people began to awaken to the need for personal security. People came together and formed builder squads all across this country; they built AR15's and shared in the cost of the jigs and other needed equipment.

I see no reason why builder squads could not be formed to share in the cost of buying, or grinding the broaches. I would like to see a supplier that sells to home builders; offer a set of broaches and files that are pre-ground in a kit form for broaching a bolt action receiver.

I spent the last 4 years trying to find the best build techniques that work with commonly found tools, machines, and materials. 4140 pre-hard steel is readily available, and can be bought in three foot sticks; this is enough for four receivers. I suggest that you build four receivers at a time.

The broaches that I used for my receiver cost me less than $200 bucks, if I only get 20 receivers out of my broaches, that's $10 dollars a receiver.

I paid around $45 dollars for my 1 ¾ inch 4140 pre-hard steel in three foot sticks, that's a little over $11 dollars for a receiver.

The barrels that I use are used Springfield and Enfield take offs that I cut down and re-chamber. I have never paid over $30 dollars for a used barrel; even the barrel blanks that I use have been less than $40 dollars.

The other parts I use are end of the day gun show pickups. The out of pocket cost for my home built rifle is around $150 dollars each, and this includes a new synthetic stock.

I built my rifle for survival purposes, and $150 dollars for a high powered bolt action survival rifle with no paper trail, in my opinion is damn good deal.

Since starting the journey in homebuilding in 1998, I have had an attitude change. I guess 8 years of Bill Clinton gun control will do that to a man, especially one that believes in freedom.

I do not encourage anyone to violate the law, local, state or federal. I don't know what the future will bring, and I can not understand why the Republican controlled congress is not repealing gun control laws, but for me, I am going to continue to build these receivers until the day I die.

The USA maybe the last armed citizenry in the world, the United Nations wants a total ban on firearms held by private citizens. Gun control is an issue like slavery that I can not accept.

If there is one single event that has caused me to change, it came after I read a book from Jews for the Preservation of Firearms Ownership titled "Gateway to Tyranny". This book clearly shows how our gun control laws are an annotated version of German gun controls both used, and created by the Nazi's.

For me the line has been drawn, everyone with the ability and desire to build their own personal use firearm should do so, even if those firearms are kept hidden or buried.

The AR 15 may be the easiest firearm for the beginner to home build, 80% lowers are available and require very modest tooling to complete. There are other types of firearms that can be built 1911's, and AK 47's are just two of the more common types being built.

Even I have another firearm design; it's for a Mosin Nagant. My Mosin design uses no broaches, but does require welding a piece of metal on the rear of the receiver for the rear tang, and trigger mounting.

Originally I was going to make that design the topic of this book. The problem with the Mosin Nagant is the bolt, if you use the Mosin bolt you're married to the Mosin cartridge. I came to the conclusion, no matter how difficult the Mauser design might seem it's the best choice for a survival rifle.

It's my sincere hope that every reader copies and shares this book with friends, family, and fellow gun owners. Anyone with the skill or desire to build a web site to feature or promote my work is welcome to do so.

I believe that our country is in trouble, if we are going to remain free, we must restore a Bill of Rights culture in this nation.

Writing a book is a new experience for me, I hope that you will be able to understand my build techniques, and build your own rifle.

The past eight years have seen a great amount of change in my life, my father who told me the story of his grandfather and his love of guns has passed on.

Sadly, the knowledge of his grandfather's homebuilding seems to have died with him. I have a feeling there was more to learn but that opportunity has passed.

Through all things good and bad, I would like to say that if it wasn't for the support of my beautiful wife I don't think I would ever have been able to finish this book. I have a feeling that she is as relieved as I am that this adventure is over.

Yours in freedom

Raymond Benwood